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The Canadian Institute.

NEW SERIES.

Volume I.

TORONTO:
HENDERSON & COMPANY, 8 AND 10 LOMBARD ST.
1898.

L. Jan. 23, 70

5th of the ... 1766
... 1774

ERRATA.

Page 5, line 18, for "Macaites," read "Macaizes."

Page 6, line 36, for "Antoeus," read "Antaeus."

Page 6, line 37, for "capturing," read "attacking."

Same line, for "who became the willing slave of their Queen," read
"that willing slave of Queen Omphale."

Page 6, line 40, for "Cassiopea," read "Cassiopeia."

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PROCEEDINGS
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THE CANADIAN INSTITUTE.

EXTRACT FROM THE ANNUAL ADDRESS OF THE PRESIDENT, A. B. MACALLUM,
M.B., PH.D.

(Delivered November 7th, 1896.)

The success which the Council has achieved during the past session in the management of the Canadian Institute has enabled the Editing Committee to formulate an improved method of publication, a method which is more in accord with the present requirements of Science. In the past our volumes of "Transactions" appeared at irregular intervals, and in some cases very long after the papers published in them had been read before the Institute. Speedy publication for scientific papers of value is a great desideratum. No investigator relishes the prospect of having his results held over for an inconveniently long time, with the chance that when they are published they may be out of touch with the literature of the subject appearing between the date of presentation and that of publication. In this case, also, he must face the risk of his results being anticipated by another worker in the same field. He, therefore, looks for speedy publication of his papers, immediately they are completed, and those means are sought which offer this advantage.

In consequence of these considerations, and desiring to attract scientific papers of merit to the Institute, the Editing Committee has decided to change the present mode of publication. It will not affect the "Transactions," which will be published as heretofore, but at the end of the Session, and containing only carefully selected papers worthy of publication in extenso. The point of departure is in the institution of "Proceedings," one number of which is to appear every two months during the session, and each will contain the short papers, and the abstracts of others read before the Institute in the preceding interval. This will ensure speedy publication, and at the same time put a premium upon brevity, while it will enable the Editing Committee to exercise greater freedom in the choice of papers for the volume of the "Transactions." If the Institute is to maintain its large list of Exchanges, it must strive for a high standard in the papers which it publishes. Having had in the past but one mode of publication, it was natural that the Editing Committee should have difficulties to contend with. Papers which contained matter of interest, from a scientific, historical, or other point of view, but were of inordinate length, were frequently offered for publication. These had to be accepted outright or rejected summarily. There was no middle course. With the plan now adopted, the Editing Committee can offer, for very short papers of value, such an opportunity for speedy publication as will considerably offset the sacrifices made for brevity. I trust that the men of science in the Dominion will avail themselves of the advantages now offered, and that the new venture will be a success.

RARE BIRDS TAKEN AT TORONTO. BY JOHN MAUGHAN, JR., ESQ.

(Read April 13, 1895).

Great Black-Backed Gull (*Larus Marinus*). Locality, 8 miles out from Toronto, Island in Lake Ontario. Date, 8th February, 1894. Measurements: spread 5 ft. 9½ ins., wing 2 ft. 7 ins., length 2 ft. 6 ins., leg 11 ins., tarsus 3½ ins., tail 8½ ins., bill 2½ ins., bill, from gape, 4½ ins., middle toe 3½ ins. Sex ♂.

Peregrine Falcon or Duck Hawk (*Falco Peregrinus Anatum*). Locality, Toronto Marsh, Ashbridge's Bay. Date, 25th June, 1894. Measurements: length 19½ ins., tail 7½ ins., wing 19½ ins., spread 44½ ins., tarsus 2 ins., middle toe 2½ ins., bill 1 in., gape 1½ ins. Sex ♂.

Remarks.—Plumage very light ashy, feathers very much battered and bare.

Marsh Hawk (*Circus Hudsonicus*). Locality, Toronto Marsh, Ashbridge's Bay. Date, 20th May, 1894, and 2nd April, 1895. Measurements: length 18½ ins., wing 20 ins., spread 3 ft. 6 ins., bill 1 in., gape 1½ ins., leg 10½ ins., tarsus 2½ ins., middle toe 1½ ins., tail 8½ ins. Sex ♂ and ♂.

Remarks.—Both these hawks are noted for their being old males in the "Blue Plumage." Colour: very light bluish ash, with pure white under wings and upper and under tail coverts. Measurements are practically identical.

Razor-Billed Auk (*Alca Torda*). Locality, Hamilton Bay, Ont. Date, 9th December, 1893. Measurements: spread 27½ ins., tail 3½ ins., wing 12 ins. Sex ♂.

Remarks.—This species is undoubtedly very rare here, as records of only two have been noted before this one. No doubt it came along with the Guillemots that were taken in such numbers at different points during the winters of 1893, 1894 and 1895.

Red Phalarope (*Crymophilus Fulicarius*). Locality, Toronto Island (east end). Date, 6th October, 1894. Measurements: bill 1 in., spread 15 ins., wing 6½ ins., tail 2 ins., leg 3 ins., tarsus 15-16 in., middle toe 15-16 in. Sex ♂.

Leash or Yellow Rail (*Porzana Noveboracensis*). Locality, Centre Island, Toronto. Date, 6th October, 1894. Measurements: length 6½ ins., spread 10½ ins., wing 4¾ ins., leg 3¾ ins., tarsus ¾ in., tail 7-16 in. Sex ♂.

Purple Sandpiper (*Tringa Maritima*). Locality, Toronto Island (east end). Date, 27th October, 1894. Measurements: length 9 ins., tail 2 ins., wing 7½ ins., spread 15½ ins., bill 1½ ins., leg 3½ ins., tarsus ¾ in., middle toe 1 in. Sex ♂.

THE DWARF DOMESTIC ANIMALS OF PYGMIES. BY R. G. HALIBURTON,
Q.C., F.R.G.S.

(Read November 14, 1896.)

For years I have enjoyed the honour of being a corresponding member of the Institute, but up to the present I have contributed nothing to its Transactions. If I have not shared the fate of the proverbial "unproductive fig tree," it is due to the forbearance of the Institute, and their charitable hope that, if spared by them, I might do better in future.

It is, therefore, with great pleasure that I offer my first instalment, a paper of interest, not on account of the way it is dealt with, but because it opens up for the first time an untrodden field of science that is likely, in proper hands, to yield important results. Whatever will hereafter account for the diminutive size of the domestic animals of pygmies will also explain the origin of the dwarf races of men; and, possibly, this may be true vice versa.

Before dealing with these little animals I must explain that, when my paper on "Dwarfs and Dwarf Worship" was read at the Congress of Orientalists at London, 1891, the subject of pygmy races was considered to belong rather to myths and marvels than to science. A quarter of a century ago Schweinfurth revealed the then incredible fact of the existence of little tribes of hunters and warriors, not much exceeding four feet high, and dwelling near the great lakes of equatorial Africa. At first he was discredited and ridiculed; but Stanley and others have since that more than confirmed his statements. But to reluctantly admit that this was the case in that remote region was the limit of endurance of incredulous scientists. When, therefore, I openly claimed that the very same race of dwarfs were to be found in the Great and the Saharan Atlas, some of them only a few hundred miles from the Mediterranean, there was a howl of indignant incredulity. My paper, which created an unexpected amount of public interest in London, and was reported in full in *The Times*, was denounced by it, *The Standard* and other papers in abusive and personal editorial critiques rarely seen in the press. I was called a Munchausen, and an inventor of Gulliver narratives; my Moorish servant and I must have been in league with the sixty or seventy natives who had testified to impose pygmies on the simplicity of the scientific world.

As the Congress had awarded a medal to me, I withdrew a reply which I had sent to *The Times*, and made up my mind that to republish these articles in four or five years' time, by the light of the discoveries that would be made, would be the most bitter reply that could be devised.

In my paper it was suggested that in early ages these Atlas dwarfs must have found their way to Europe, and that they still survive there in popular tradition as fairies and dwarf smiths with magic powers; and that dwarf tribes were also the subject of very similar traditions in the West Indies and America.

After that it was discovered and shown by me that there are dwarf survivals in the Pyrenees, and also in America.

One of my most persistent critics was among my friends, called "fascinating subject," as this was a pet term of his. Judge my dismay in June last, on reading in an article on "Pygmy Races," the following ominous sentence, with which it begins. "Professor Starr's article on 'Pygmy Races of Men' in *The North American Review* contains much interesting information regarding a curious and fascinating subject." To my relief I found that he admitted most fully all my contentions. The existence of dwarf tribes in the Atlas, similar to the Akkas of

Equatorial Africa, "had been demonstrated"; that there are diminutive Nanos in the Pyrenees was also admitted, and also that strong evidence had been adduced as to the existence of dwarf survivals in America. I could hardly believe that the writer was my old friend but for a significant omission. He fully accepted my discoveries but forgot to mention my name in connection with them. Still, to have converted him to that extent was eminently satisfactory.

He concludes with some very sensible remarks, which are especially interesting in connection with an even still more fascinating subject, "The Dwarf Domestic Animals of Pygmies." "It is evident that the existence of pygmy races has passed out of the region of myth and fable into that of history and science. Our information regarding these strange races is still incomplete and inexact, but it is being steadily augmented and brought in line with accepted results in biology and anthropology. The facts already adduced suggest many interesting reflections, but perhaps raise more problems than they solve. It seems clearly impossible (?) to regard the pygmy races as owning a common origin, although their tendency to conform to a single fairly well-defined type is very curious.

"Is their case one of degeneration, owing to some special circumstances of climate and environment, or do they represent a remnant still remaining in a stage of development long since left behind by the rest of the human species? We cannot say with certainty, but such questions may yet become capable of solution, when our information on the subject has become more extensive and exact."

In 1890, when I visited Morocco to look into the subject of racial dwarfs there, one of my first informants as to their small animals was a halfbreed dwarf at Tangier, about four feet high, who is to be seen in the Soko, or market place there. In my "Dwarfs of Mount Atlas" (p. 25), we find him say, "the dwarfs are very brave, and great hunters of ostriches, having small, swift horses, that are called by a name, meaning 'those that drink the wind,' and that are fed on dates and camels' milk, and are very lean, and, judged by their looks, would be set down as worthless. This description of these ostrich hunters agreed with that given me by my Berber servant in 1888." A Rabbi from Ternata, on the Dra, also said (see p. 29), "There are many of them (the dwarfs) near the Soudan. The Arabs fear them, and pay to be allowed to pass through their country. Their horses can do without water for four days, and are called dwiminagh ('they that drink the wind')."

There is a place called Adwarfi, two or three days to the south-east of Taflet, which is a great resort of the dwarfs, and a part of the Saharan Atlas, in that region (I assume), is called the Black Mountains, where is the River Dora, and where there are many caves, in which the dwarfs live with their cattle. They have an Arabic name, meaning "the people that own cattle." A little Ait Atta from near Adwarfi, and also afterwards a Jew from that region, described the dwarfs there as living in hillocks, in which there are very small entrances, leading to a central chamber, into which, at night, they drive their cattle, which are very small. Mr. MacRitchie, in his "Testimony of Tradition," speaks of the "weems" of Scotland, which are precisely similar structures to the hillocks of the Sahara; and in one of them, he says, in its central chamber, were found the bones of a small ox.

In 1893 Mr. Carlo Bruzeau, of the Villa de France Hotel at Tangier, told me that twenty years ago, during a time of famine, he "saw a man bringing into Mogador for sale, a string of shaggy ponies. When asked whence they came, the Moor replied, 'from the mountains (the Saharan Atlas); there, horses, sheep, goats, cows, men, all are very small.'"

In the same year the dwarf tribe that inhabits the Great Atlas, not much more than a day's journey from the city of Morocco, were described to me as owning little sheep, donkeys, goats, and cows; and a Moor offered to bring some to Mogador, should I wish to buy some of them.

The Barbary donkey is well known, a pretty tiny specimen of the breed, generally black, and very active and strong for its size.

Nearly always, wherever pygmy tribes exist, or must have once existed, we find very small domestic animals. Bent, in his "Mashonaland," says that they are very diminutive throughout South Africa. This even extends to the poultry. A hen's egg there is hardly larger than a pigeon's egg.

This is also the case in Europe. Wherever there are survivals or very distinct traditions of early dwarf races, there we invariably find small breeds of domestic animals. In Brittany we not only have occasional survivals of very small people, but also very diminutive cows and ponies. In Shetland and the Hebrides we have very conclusive traditions as to dwarfs, and there, too, we find little Shetland ponies, small, "black-faced sheep," etc. In Wales, too, with its undersized, dark-complexioned people, we meet with little Welsh sheep and cows. In the same way in Kerry, where the tales of the Skillimilinks, and "the little red-headed blacks" are to be met with, there we have the same types of animals. The little Kerry cows are famed for their good qualities. In Galloway, too, in Southwestern Scotland, where history tells us of the warlike, small-sized Pechts, who claimed the right to lead the van in armies, we find the well-known ponies called "Galloways," as well as small cows.

The popular belief of the herdsmen and cheesemakers (Macaites) of the Vosges Mountains, not only that there are pygmy herdsmen there, who dwell in caves in the precipitous cliffs of that region, but also that these dwarfs have dwarf cattle, is most interesting. On this point I may quote the following passages from my paper on "Dwarf Survivals and Traditions as to Pygmy Races" (see *Proceedings of the American Association for the Advancement of Science*, Vol. XLIV., 1895):

"Thirteen years ago my attention was attracted by the name of some cliff dwellers in Abyssinia, which Jean Temporal, in his translation of an early Portuguese book on that country, calls 'Vosges.' As I had, in 1863, suggested (see Haliburton, *New Materials for the History of Man* (1863), pp. 14, 23, and note, 41, 74) that there must have been a migration from Africa to Europe in early ages, I made a note of these facts, intending some day to inquire whether there are not traces of cliff dwellings, or cliff dwellers, in the mountainous country of Alsace, 'the Vosges.' In 1892, as Admiral Blomfield Pasha, of Alexandria, and Mrs. Blomfield, were about to spend six weeks in the Vosges, I asked them to look into the question. In a few weeks I received a local guide-book, which more than bore out my anticipations. In the Guide Joanne, Geradmer (Paris, Libr. Hachette & Cie, p. 26), we are told that La Schaume, of Nisheim, which surrounds Wurtzelstein, it is believed, is inhabited by a kindly-disposed race of dwarfs, who, when the herdsmen descend to the lower valleys with their herds in the autumn, pasture their cattle, which are of very small size, in the upper pastures, and make cheese till the spring. Among different authorities cited is *The Foyer Alsacien*, by Chas. Grad." "In 1893 (i. e., after I had heard from Blomfield Pasha), I learned in Morocco that, two days south of the Great Atlas, there is a high mountain called Voshe, the inhabitants of which are dwarf cave-dwellers, who are called Ait Voshe (the Voshe Tribe). Professor Schlichter says that the Akka dwarfs of Equatorial Africa are known to their neighbors as Voshu, and also Tiki-Tiki, names connected with the Akka dwarfs of Southern Morocco, who are also called Jed-ibwa 'the Fathers of our Fathers')." "

The range of the name for dwarfs, Tiki, or Tiki-Tiki, is almost world-wide. Of the 49 primordial dwarfs, whose creation preceded that of the human race, according to Voluspa of the Icelanders, one was called Nain, and another Theckr. In Germany we meet with the name Tuecke-Kobbold, and in Polynesia with Tiki-Tiki, the name of the dwarf Creator, and in Peru the Creator was called Ticci Ccapac.

When the Akka, or Tiki-Tiki of Equatorial Africa wandered north to Europe, they must have brought their diminutive cattle with them, for in Baker's "Albert

Nyanza" (1866, p. 91), a region where the widespread Akka, or Voshu, are to be found, we are told that "the cattle there are very small. The goats and sheep are quite Liliputian."

In Ceylon, the original inhabitants of which are the diminutive Veddahs (called often "Devil-dancers"), there is a very diminutive breed of sacred oxen, for their small size is put down to some wonderful myth about Buddha. These oxen are very nimble-footed, and are used in carriages by the natives, as they can easily travel eight miles an hour.

A friend of mine told me recently that in a part of Bengal where he lives, there is a very diminutive breed of oxen, which are very swift; and it is considered by the rich Hindoos the correct thing to have a carriage drawn by six or eight of them.

But all this was known to the ancients over 2,000 years ago. Ctesias, a physician of Artaxerxes, who travelled in Asia, and described the pygmy race that he there saw, says that they owned diminutive flocks, sheep the size of a lamb, small donkeys and oxen, and horses and mules not larger than a ram is in Greece. (See Ctesiae fragmenta, No. 57, 11, Didot).

Aristotle states that the pygmies live near the lakes from which the Nile flows, "and this is no fable, for there is really, it is said, a race of dwarfs, both men and horses, which lead the life of Troglodytes." (See Hist. Animal, VIII. 2).

Strabo, who was a sceptic as to the pygmies, though he described small races of men, says of the Western Ethiopians (evidently the dwarfs of the Dra and the Northern Sahara, whom I have alluded to), "their mode of life is wretched. They are, for the most part, naked, and wander from place to place with their flocks. Their flocks and herds are small in size, whether sheep, goats or oxen; the dogs also, though fierce and quarrelsome, are small" (See Bohn's Classical Library, Vol. III., p. 270, 1857).

It was pointed out in 1891, in my "Dwarfs of Mount Atlas," that pygmies are supposed in Northern Morocco and in Nubia to be Cyclops, and that, as the dwarfs of the Atlas, like other natives of Southern Morocco, wear a singular bournous, on the back of which is worked an immense eye, a yard in length, "the people with the eye" must in time have become "the people with only one eye." This view, as well as my contention that the dwarfs of the Atlas have little domestic animals, are confirmed by Robert Brown, Jr., who, in his "Neptune," says that the Cyclops of the Odyssey were an agricultural people of North Africa, who had diminutive cattle, the milk of which yielded very rich cream.

The dwarfs of the Atlas revenged the death of their giant brother, Antoeus, by capturing Hercules, who became the willing slave of their Queen. Under many different names, this great African Queen frequently appears in early Greek mythology. Dating back to an era before the dawn of astronomy, she and her daughter, as Cassiopea and Andromeda, were, with Hercules, placed in the heavens as northern constellations by that father of astronomy, Atlas, who, according to Homer, "knew all the stars, and the remotest parts of the ocean," and who taught Hercules astronomy. "The fat Queen of Pount" still survives on the monuments of Egypt, which, according to Mariette Bey, represent her as a pygmy, and in popular traditions as to the ruins of Poun or Pount, at the head of the Dra Valley, in Southern Morocco, where, in time of drought, Queen Mena is still invoked. Her mantle, no doubt, was believed to have descended on that brave Jewess, called by the Arabs, Queen Kahina ("the sorceress"), under whom the Berbers for a time rolled back the tide of Moslem invasion. A vague idea has for years existed south of the Atlas that Queen Victoria is destined to rule over that country!

I have omitted to refer to two curious points: that there are, in several isolated and inaccessible localities in the Southern States, little communities, composed of survivals of those pygmy tribes that have disappeared from the west coast of Africa; and also that there are on the Atlantic seaboard little ponies, the descendants,

probably, of a small breed that belonged to these dwarfs, and that were shipped with them to America. Strange to say, their name is "Teki horses."

Dr. Weir's interesting article in the *Popular Science Monthly* for June, 1896, on "The Pygmy in the United States" (which, however, does not refer to these small horses), will well repay a perusal.

I invite the attention, not only of anthropologists, but also of zoologists, to this subject: Are these little breeds the original stock and have domestic animals gradually become larger and stronger, just as cultivated plants have; or have scores of thousands of years of privation dwarfed them and their pygmy owners?

It is very desirable that zoologists should carefully study and apply the investigations of Yale naturalists and palaeontologists as to the origin of the horse in America, which would seem to indicate that the ordinary horse had an even smaller prototype than the little "drinkers of the wind" of the Sahara, in a fox-like animal with five toes, developing in later ages into a larger, horse-like animal with a cloven foot. "After that the deluge"—some catastrophe that put a final stop to horse-raising in America in primordial times.

I also suggest a point which zoologists may follow up with good results.

Mr. Cunninghame Graham, three or four years ago, in an article on Argentina, says that the horse of the Pampas differs from the ordinary horse, the lumbar vertebrae of which are one more in number than those of the Pampas horses. This, he says, also applies to Barbs, and he thinks that the Spaniards must have brought out Moorish horses with them to Argentina. I tried, when last in Morocco, to get a skeleton of a Barbary horse examined by a veterinary surgeon, but did not succeed.

If the Barb differs also from ordinary horses, it probably got its peculiarity from the little breed of ponies in the Sahara.

It is also very important to ascertain whether the latest type of fossil horses in America resembled the Barbs or the common horse in this respect.

Henceforth we have immensely improved chances of solving the problems of the origins of small breeds of domestic animals, and of pygmy races of men—for what will explain the one, will also settle the other.

As respects the latter, the tendency of scientific thought is to regard dwarf races of men as having been the original and earliest specimens of humanity on the earth, and to yield to them the place so long occupied by a supposed "missing link." The latest traveller in Africa, Professor Donaldson Smith, writing last summer to *The World* an account of Abyssinian dwarfs discovered by him, says: "Although they live among other native tribes, they differ totally from them as respects their principal ethnological features. This fact strengthens the theory that the African pygmies are not degenerate specimens of the tribes among whom they live, but are the remnants of the first and original population of the Dark Continent."

Mgr. Lerey, Papal Nuncio to East Africa, says the same thing, and asserts that the dwarfs think so, too, and despise all the larger races as parvenus. They claim to be the first, and oldest, and noblest inhabitants of Africa.

*(Note)—After this paper was written it was found that the fossil horse resembled the Barb in this respect. It may be worthy of mention, that a review of the latest book on Anthropology, Hutchinson's "Prehistoric Man and Beast" (Appletons, N.Y.), says: "Certain analogies lend weight to the idea that possibly Stonehenge was erected by the dwarfs or fairies, who, in a previous chapter, are shown to have been a real people. Various writers have come to the conclusion that a dwarf population akin to the Lapps were the actual inhabitants of the 'fairy knowes,' or underground megalithic structures, and became in time the elves and fairies of folk lore."

THE GAMETOPHYTE OF *BOTRYCHIUM VIRGINIANUM*. BY EDWARD C. JEFFREY,
B.A., LECTURER IN BIOLOGY UNIVERSITY OF TORONTO.

(Read November 21, 1896.)

A complete description of the gametophyte of the Ophioglossaceae has long been a desideratum.

Since the discovery by Mettenius, in 1856, of the subterranean prothallium of *Ophioglossum pedunculatum*, and by Hofmeister, in 1857, of that of *Botrychium lunaria*, nothing has been added till recently to their necessarily incomplete accounts of the gametophyte in these species. Our latest knowledge on this subject is derived from a brief description of incomplete material of the prothallium of *Botrychium virginianum* found in 1893 at Grosse Isle, Michigan, by Professor Douglas Campbell, which was published in the proceedings of the Oxford meeting of the British Association in 1894.

During the summer of 1895 the writer secured a large number of prothallia of the same species at Little Metis in the Province of Quebec. On examination it was found that the material thus obtained afforded a complete elucidation of the development and structure of the antheridia and archegonia, and a less satisfactory series of stages in the segmentation of the embryo. Last summer the remaining prothallia were removed to the number of about six hundred, and, although they have only been partially studied yet, owing to technical difficulties in embedding them, those examined have supplied all the lacking stages of the development of the young sporophyte.

It is proposed at the present time to furnish a brief account of the features of interest—a fuller description will shortly appear in the Transactions of the Canadian Institute.

All the younger prothallia were found in a single circular depression of sphagnum moss about ten feet in diameter, near a corduroy road, running through the wooded margin of a peat and huckleberry swamp at Little Metis, P.Q. Older prothallia were abundant with those bearing fertilized and unfertilized archegonia and younger embryos.

I have also found young sporophytes of several years' growth in the woods on the heights back of Metis; in the "Flats" below the "Whirlpool" on the Niagara river, and also in rich woods along the valley of the Don, near Toronto. In all the examples last referred to the young spore plant was still attached to the gametophyte. It seems probable that the prothallia of our common Canadian species of *Botrychium* are much commoner than has been hitherto supposed. It is necessary to add, however, that although my attention has been directed to the subject for some three years past, I have not yet succeeded in finding the younger stages of the prothallia in any other spot than the sphagnum basin in the swamp at Little Metis.

The gametophyte of *Botrychium virginianum* is of flattened oval shape, the narrower end of the prothallium being terminated by the growing point. My examples are from two to eighteen millimetres in length, by one and a-half to eight millimetres in breadth. Their thickness increases from the growing end backwards. The sides and lower surface of the prothallium are covered in younger specimens with multicellular hairs. In older plants these tend to disappear. The middle of the upper surface is occupied by a well-defined ridge, upon which the antheridia

are situated. The archegonia are found on the declivities which slope away from the antheridial ridge.

As might be expected, the younger sexual organs are found nearer the growing point than those of greater age.

A cross section of the prothallium reveals to the naked eye the fact that the lower part of the gametophyte is composed of tissue which is yellowish in colour, and from which a thick oil exudes, even when the plant has been lying in ninety per cent. alcohol for months. The upper portion of the prothallium tissue, upon which the generative organs are situated, is white in colour and free from oil. A long section of the prothallium shows the same distribution of yellow oil-bearing and white oil free tissue as the cross section, but demonstrates that the oil-bearing stratum is both absolutely and relatively much thicker in the older parts of the plant.

Microscopic examination shows that the oleiferous tissue has its cells occupied by an endophytic fungus and a very abundant protoplasm.

The fungus, so far as it has yet been studied, seems to be a sterile *Pythium*, possibly the same as that found by Treub, Goebel and others in the prothallium of species of *Lycopodium*. The writer hopes to study the fungus more closely in a living condition during the next period of vegetation. The fungus filaments can be seen passing from the prothallium to the outside medium by way of the root hairs.

The antheridia, as has been already stated, occur in numbers on a ridge running lengthwise on the upper surface of the prothallium. The young antheridia originate behind the growing point from a single superficial cell. This divides transversely the outer half, giving rise to the outer antheridial wall and the inner half by repeated simultaneous divisions to a large number of spermatocytes. The fully-developed antheridium is largely embedded in the antheridial ridge, and projects only slightly above its surface. The formation of the spermatozooids has not yet been carefully studied, but seems to resemble closely that described in the *Marattiaceae* and *Equisetaceae*.

The spermatozooids are unusually large in size, but otherwise resemble the ordinary fern type, and consequently differ from the biciliate, moss-like spermatozooids of the *Lycopodiales*.

The archegonia are confined to the sloping sides of the upper surface of the prothallium. Unlike the antheridia, young archegonia, although most abundant near the growing point, may be formed on almost any part of the archegonia-bearing surface. The archegonium mother cell is superficial, and is distinguished from its neighbours by a larger nucleus and a more abundant protoplasm. It first divides transversely into a shallow outer cell and a deeper inner cell. The inner cell divides again, and as a result the young archegonium consists of three cells. The most external of these, by subsequent divisions, gives rise to the neck of the archegonium. The internal cell is the basal cell. It also divides into a plate of cells, sometimes composed of two layers and distinguished by their richly protoplasmic contents. The middle cell of the young archegonium series gives rise by division to the neck canal cell and the ventral cell. The former becomes binucleate, but never divides into two cells. The latter, just before the maturation of the archegonium, divides into the egg-cell and the ventral canal cell. The ventral canal cell is broad, like that of the *Marattiaceae*.

In the ripe archegonium the nuclei of the cells of the upper stories of the archegonium neck become chromatolysed. I do not know yet whether this feature is peculiar to *Botrychium*.

The fully-developed archegonium is sunk into the prothallium, and only the neck projects above its surface. The cervical cells are in four rows as in the other *Pteridophyta*, and the terminal ones spring apart when the egg is ripe.

Spermatozooids are frequently found in contact with the egg. After fertilization the egg grows to many times its original size, and the reduced protoplasm contains a large hydroplastid.

The first division of the o-spore is across the long axis of the archegonium. The next division is parallel with the long axis of the prothallium, and at right angles to the first. The third cross wall is in the transverse direction of the prothallium, and at right angles to the other two. I have been unable to follow satisfactorily the subsequent divisions.

The organs appear very late, and only after the embryo has attained a large size. The root is the first of them to emerge, and the proliferation of cells, indicating its place of origin, is long unmarked by the presence of an apical cell. The cotyledon, stem apex, and foot appear nearly simultaneously.

The root and cotyledon originate from the upper part of the embryonic mass; the foot and stem apex from its lower cells.

The apex of the root in many cases is in the same straight line with the canal of the archegonium neck.

It seems hardly possible to derive the organs from definite octants of the embryo.

The growth of the root ruptures the calyptra, and its exit is followed somewhat later by that of the cotyledon. The latter is not a bi-laterally symmetrical structure, as in most ferns, but is of the same palmate type as is found in the Osmundaceae. The cotyledon begins to assimilate as soon as it reaches the surface of the ground, and thus resembles that of *Ophioglossum pedunculatum*.

There seems to be no evidence to indicate that more than the cotyledon appears above ground in the first season of the young plant's growth. In following summers apparently only a single leaf is produced, as is the case with the older plant. I have found young sporophytes, bearing their sixth leaf, still attached to the mother prothallium; and, as I have never found more than one leaf on the spore plants at once, and as the leaves, like other organs of this species of *Botrychium*, are extremely resistant to decay, I am reasonably certain that such examples were in the sixth year of their existence. This longevity of the gametophyte is of some interest.

One frequently finds two sporophytes on a single prothallium, and in many of these cases the apex of the prothallium is bifurcated. In one case I found two spore plants which had arisen from a single embryo. In another case I discovered two tracheids in a prothallium in the vicinity of a decayed young spore plant. The latter may have been of apogamous origin, as a similar phenomenon generally accompanies apogamy. I have not yet studied thoroughly the growing region of the prothallium, as it is best examined in longitudinal sections of the gametophyte. So far as I have investigated the matter, there seems to be evidence of the existence of an apical cell.

THE HISTOLOGY AND PHYSIOLOGY OF THE GASTRIC GLANDS. BY R. R. BENSLEY, B.A., M.B., ASSISTANT DEMONSTRATOR OF BIOLOGY, UNIVERSITY OF TORONTO.

(Read November 28, 1896.)

PRELIMINARY NOTICE.

In nearly all vertebrates, in which the histology of the stomach has been investigated, the mucous membrane of that portion immediately preceding the pyloric orifice has been found to contain glands differing in certain characters from the glands of the rest of the stomach, and known technically as the pyloric glands. The morphological relation of these glands to the other gastric glands in the lower vertebrates has excited little interest, but in the mammalia, in which the subject assumes great physiological importance, this relation has been the subject of numerous researches, and has been examined from widely different points of view. Heidenhain¹ and Ebstein² compared the cells of these glands with the chief cells of the fundus glands in respect to the action on them of dilute acids and alkalis, and to the appearances presented in different phases of secretory activity, and came to the conclusion that the two kinds of cells were of similar nature. Further force was imparted to this conclusion by the discovery that the pyloric mucous membrane contained a ferment capable of digesting fibrin in the presence of dilute hydrochloric acid, and by the experiment of Heidenhain,³ who established a pyloric sac entirely separate from the fundus mucosa, which, even after five months yielded a secretion rich in pepsin.

The method adopted by Heidenhain and Ebstein in investigating the physiological and morphological value of the pyloric glands was to a certain extent the correct one, and the reason that it did not lead, in their hands, to a more convincing result was that they examined cells in which only a portion of the elements of the living cells was preserved. The researches of Langley,⁴ alone, and in conjunction with Sewall, have taught us that the secretion of pepsin is intimately connected with the formation and disappearance of coarse granules in the chief cells, and he has offered us the most convincing proof that these granules are the zymogen of Heidenhain,⁵ Ebstein, and Grützner,⁶ and comparable to the granules observed in the pancreas and salivary glands. Any cytological research which does not take into consideration these zymogen granules cannot fail to lead to erroneous results. Unfortunately, it has been found difficult to preserve these granules, and in his first observations on the mammalian glands, Langley depended largely on fresh, or living material. Subsequently he found that in some animals the granules could be fixed, and the part taken by them in secretion investigated by the use of solutions of osmic acid.

Langley and Sewall observed that the coarse granules discovered by them in the fundus glands were not to be found in the pyloric glands, and concluded that the appearance of granules in the cells was not a necessary feature of zymogenesis.

(1) Arch. für Mik. Anat. Bd. VI., p. 368.

(2) Arch. für Mik. Anat. Bd. VI., p. 515.

(3) Pflüger's Archiv. Vol. XVIII.

(4) Journal of Physiology. Vols. II., III., and others.

(5) Pflüger's Archiv. Vol. X., and Hermann's Handbuch, Vol. V.

(6) Pflüger's Archiv. Vol. VIII.

Relying on their observation that in the rabbit there is a gradual diminution in the number of granules in the chief cells, from the fundus along the greater curvature, and on the undoubted fact that the pyloric secretion contains a proteolytic ferment, these observers concluded "that the pyloric gland cells and the chief cells of the fundus are fundamentally the same," and that "the chief cells of the fundus" are "a highly differentiated form of the pyloric gland cells." Stohr⁷ in 1882 arrived at a similar conclusion, as a result of his researches on the stomach of man, the cat, dog, and badger.

Many investigators, however, as a result of physiological experiment and observation, have come to the conclusion that the pyloric gland cells are something quite different from the chief cells of the fundus gland. Among these may be mentioned Nussbaum,⁸ Sappey,⁹ Bonnet,⁹ and Bikfalve, who regard the pyloric glands as mucous glands. The most recent contribution to this subject is that contained in the *Lehrbuch der Vergleichenden Mikroskopischen Anatomie*, published this year by Oppel, of Freiburg. From an exhaustive examination of the literature of this branch of research, and from personal observation, this author, concludes that "Die Pylorusdrüsenzellen sind Zellen sui generis welche sich sowohl vom Oberflächenepithel wie von den Hauptzellen unterscheiden. Sie sezernieren peptinhaltigen Magensaft."

One has only to consider the conflicting nature of the results achieved, or to observe the various ways in which similar observations have been interpreted; to convince oneself that the solution of the problem of the morphology and physiology of the mammalian pyloric gland is not to be attained by the ordinary methods of physiological research.

It appeared to me that some information might be afforded by a careful study, of the structure of the cells of the various gastric glands, at different periods of digestion, together with a comparison of the structure of the cells in the various vertebrate classes. In order that this investigation might not be open to the objection I have urged in reference to the work of Heidenhain and Ebstein, it was necessary to find some agent that would fix equally well the form and contents of the cell. To the difficulty of accomplishing this, I have already alluded, in speaking of the work of Langley, who found that by the use of osmic acid he could preserve the granules in the chief cells of a few mammals only. It has since been found that mercuric chloride, in saturated aqueous solution, would fix perfectly the zymogen granules of many glands. This reagent, as well as the various osmic acid mixtures, were tried and found to possess certain disadvantages. Whilst they fixed perfectly and satisfactorily the cells of the surface, and of the deepest portions of pieces of mucous membrane immersed in them, the zymogen granules had quite disappeared from the middle regions of the glands. Alcoholic solutions of mercuric chloride were then tried, with the result that whilst the zymogen granules of the whole gland were well preserved, the cells themselves had undergone considerable change of form. It was subsequently found that the addition of an equal volume of two per cent. aqueous solution of potassium bichromate to the alcoholic solution of mercuric chloride, would prevent the shrinkage of the cells, and at the same time effect a satisfactory fixation of the zymogen granules in all parts of the glands containing them.

With the help of this reagent I have investigated the stomachs of several mammals, and of members of the lower vertebrate classes, and have been led to conclude, that the relationship of the pyloric glands to the glands of the fundus region is, within certain limits, a constant one, and that the pyloric glands are to be regarded as feebly differentiated structures, corresponding in the nature of their cells to the upper portions of the fundus glands.

(7) *Archiv f. Mik. Anat.* Bd. XX.

(8) *Archiv f. Mik. Anat.* Bd. XXI.

(9) See Oppel. *Lehrbuch der Vergleichenden Mikroskopischen Anatomie*, p. 269.

Among mammals, I have found the cat most suited to experimental research, on account of the large size of the zymogen granules, and in this preliminary paper I will confine myself to an account of the results attained by observation of the gastric glands of this animal in various stages of secretion, and reserve for the full paper, to be published shortly, the confirmatory facts elicited from an examination of the stomachs of other mammals, fishes, amphibia, and reptilia.

The chief cells of the fundus glands may be divided into two groups, those of the body and those of the neck of the gland. The differences between these two kinds of cells will be minutely described.

If the fundus glands of an animal that has fasted for twenty-four hours be hardened in the alcoholic sublimate bichromate mixture, the chief cells present the following characters:—They are cubical or pyramidal in shape, the base of the pyramid being usually directed towards the lumen of the gland. In preparations stained in haemalum and eosin, the body of the cell is found to contain a network of large polygonal meshes of equal size, and pervading the whole cell. In secretions stained in saffranin, or gentian violet, or the iron alum haematoxylin of Heidenhain, the cell is filled with granules of large size, the zymogen granules. In the Ehrlich-Biondi mixture the network stains red, and it is then seen that each mesh of network corresponds to a zymogen granule. The apparent network is really the optical section of the partitions between the spaces in which the zymogen granules lie. The nuclei are round or oval, occasionally slightly irregular, and placed near the base of the cell. They possess a well-defined chromatin network, and one or two large eosinophilous nucleoli. I have directed considerable attention to the structure of the nuclei in the different phases of secretion, with a view of determining if changes similar to those described by Platner, Ogata, and others in the nuclei of the pancreatic cells are to be observed in the gastric chief cells. So far, however, I have been unable to demonstrate any changes, with the exception of the slight irregularity of outline sometimes seen in the resting cell. This, I feel inclined to attribute, rather to compression by the secreted products, than to spontaneous change of form.

In an animal that has been continuously digesting for a period of six hours the chief cell is distinctly marked off into two zones. The inner zone is still filled with large granules, between which may be seen in Ehrlich-Biondi stained sections, the red stained meshwork of hyaline protoplasm. The outer portion of the cell contains no granules, but is occupied largely by a substance which has a peculiar affinity for nuclear dyes, such as haematoxylin. This substance possesses an obscurely fibrillated structure, the fibrillae being placed side by side in the base of the cell, so that one is at first reminded of the appearance of the striated epithelium of the intralobular ducts of the salivary glands. On closer examination it may be seen that the fibrillation in the outer portion of the chief cell is not so regular, nor are the fibrillae as distinct from one another as in the salivary ducts. The fibrillae are also of larger size, and irregularly swollen at intervals so as frequently to mask the fibrillated structure. The form taken by this substance in the base of the cell, particularly when it is present in small amount, frequently reminds one strongly of the figures published by Macallum,⁽¹⁰⁾ Eberth, and Mueller,⁽¹¹⁾ and others, of the nebenkerne in the pancreatic cells of the amphibia, and one is led to inquire if these structures are not of similar nature. The amount of this fibrillated substance in the cell, under normal conditions, varies inversely with the number of zymogen granules, and one can only conclude that the chromophile substance in the base of the cells breaks down during rest, and thus takes part in the formation of zymogen granules, which is then actively progressing. Mouret⁽¹²⁾ takes a similar view of the nature of the chromophile fibrillated substance in the outer portion of the

(10) Transactions of the Canadian Institute. Vol. I. 1890.

(11) Zeitschrift f. Wissenschaft. Zool. Bd. 53. Supplement.

(12) Journal de l' Anatomie. 1895.

pancreatic cells of the dog, and he suggests the name of "pre-zymogen" for the substance. Some information as to the nature of this substance is afforded by the researches of Dr. Macallum, who describes¹³ the differences in staining exhibited by the nucleus and plasma of the exhausted and resting pancreatic cell, and explains this difference as follows:—"The chromatin of the nucleus of the pancreatic cell gives rise to a substance which we may call "prozymogen," sometimes dissolved in the nuclear substance, sometimes collected in masses (plasmosomata), and finally diffused into the cell protoplasm, uniting with a constituent of the latter as zymogen." In a subsequent investigation¹⁴ into the distribution of assimilated iron compounds in animals and vegetable cells, Dr. Macallum found diffused in the cytoplasm of the outer zone of the chief cells, and, with two exceptions, in the cytoplasm of all other glands examined by him, a firm compound of iron, and his observations led him to conclude that this iron compound was the prozymogen of his earlier researches. It seemed probable that the fibrillar chromophilous element observed by me in the outer zone of the chief cell was the prozymogen of Dr. Macallum's investigation; and this proved to be the case. A convenient means of proving this was afforded by the fact that the chief cells of the greater curvature of the rabbit's stomach contain at all periods of digestion a very large amount of the chromophile substance, which in the exhausted phase almost fills the entire cell, the zymogen granules being then confined to a narrow band next to the lumen. Sections of this mucous membrane give no immediate reaction for iron with ammonium sulphide, but after three hours' treatment with a three per cent. solution of sulphuric acid in alcohol, at a temperature of 40 degrees C., those portions of the chief cells containing the chromophile substance take, with acid ferrocyanide solution, a deep Prussian blue color, which is so intense as almost to mask the nucleus of the cell. The Prussian blue reaction also shows the same fibrillar structure as is observed in sections stained in haematoxylin. We may, therefore, use the term "prozymogen" for this substance wherever it occurs.

It is not in the chief cells of the stomach and in the pancreatic cells alone that the prozymogen assumes the fibrillar form. I have observed similar structures in the serous glands of the gustatory area of the rabbit and dog, and it is possible that the rod-like structures described by Solger¹⁵ in the basal portion of the cells of the human submaxillary gland, and by Erik Mueller¹⁶ in the cells of the submaxillary of the guinea pig, may belong to the same category. The fibrillation in the prozymogen of the gastric gland cells may be observed in the fresh cell, examined in aqueous humour, and is, therefore, not the product of the action of reagents. It may be also seen in sections fixed in Hermann's or Vom Rath's osmic acid mixtures, and in aqueous sublimate.

The cells of the neck of the gland are quite different in appearance from those of the body. At no period of digestion do they contain either prozymogen or granules of zymogen. The same remark is applicable to the chief cells of the short collecting duct (sammelgang of Bizzozero), and to the cells of the lower portion of the mouth of the gland. The cells of these three regions have many features in common, and will be described together. As a starting point, I will describe the cells of the upper portion of the neck of the gland.

These cells are usually conical or pyramidal in shape, wedged in between the larger oval border cells of this region of the gland in such a way that the broad base of the cell is directed towards the lumen. In vertical sections of the mucous membrane, from one to four of these cells may usually be observed between each pair of the border cells. Two zones may be distinguished in the cells, an outer protoplasmic zone of fine reticular structure, staining readily with eosin, and an

(13) *Op. Cit.*

(14) *Quarterly Journal Microscopical Science*. Vol. XXXVIII., Part II. New Ser.

(15) *Anatomischer Anzeiger*. Bd. IX.

(16) *Archiv f. Mik. Anat.* Bd. XLV.

inner zone presenting an irregular network of much larger meshes, and containing a secreted substance, which behaves in a peculiar way to staining agents. By the ordinary stains this portion of the cell appears clear and transparent. The substance contained in the inner zone of the cell appears to be in some respects similar to mucin. It gives a faint metachromatic red stain with thionin, and stains intensely with Bordeaux R. and Indulin. The latter dye has rendered me considerable service in determining the distribution of this kind of secretion in the stomach. I have found the most satisfactory method of applying this stain to be in the form of Huber's blood fluid, consisting of two grammes each of indulin, eosin, and aurantia, dissolved in thirty grammes of pure glycerine, and diluted with four hundred times its volume of distilled water before use. Sections of the fundus mucous membrane immersed in this fluid for one-half hour or longer, show all parts stained red, with the exception of the blood corpuscles, which are yellow, the nuclei of the cells and the mucigenous borders of the surface cylindrical cells, which take a faint haematoxylin tint, and the secretion in the cells of the upper portions of the glands, which takes an intense dark blue color. Stained secretion may also be observed in the lumen of the gland. In sections stained thus the appearance of the inner zone of the cell is different from that above described. It is now found to be pervaded by a close-meshed network of coarse fibres, both the network and the substance enclosed in its meshes being indulinophilous, and often presenting a vacuolated appearance. This appearance seems to me to be due to the formation of a secondary reticulum by precipitation in this form of the solids of the secretion. At the junction of the two zones of the cell the reticulum of the outer zone is much finer in texture and is chromophilous, so that in sections stained in haematoxylin alone, the cell appears to be subdivided by a blue stained band into the two zones. In sections stained in the indulin mixture it is frequently seen that a small quantity of indulinophilous material is diffused through that portion of the outer zone of the cell, between the chromophilous band above referred to and the nucleus. The size of the indulinophilous zone varies with the position of the cell. In the upper part of the neck of the gland it involves only a small portion of the cell, but on passing down the gland, increases gradually in width, until at the lowest portion of the neck of the gland it fills nearly the whole cell. The nuclei of these cells are placed near the base, and vary in shape with the amount of secretion present; in those cells, which possess a large protoplasmic zone, the nuclei are oval or round; in the cell filled with secretion they are irregular and flattened. It is only in cells, however, in which the indulinophilous zone extends to the nucleus that any irregularity of shape is to be observed. Mitoses may frequently be observed in those cells, even when filled with secretion. Among the indulinophilous cells of the lower portion of the neck may be observed a few zymogenic cells. An occasional indulinophilous cell may also be observed among the chief cells of the body of the gland, and these are probably the cells observed by Pilliet,¹⁷ Trinkler,¹⁸ and others, and regarded as stages in the transformation of border into chief cells, or vice versa.

The cells of the collecting duct, and the lower cells of the mouth of the gland, also contain indulinophilous secretion, in the shape of a rounded clump in the midst of the protoplasm of the cell, near the nucleus, possessing the same structure and staining properties as the inner zone of the cells of the gland neck. Passing up the mouth of the gland, this clump gradually approaches the free surface, and loses its indulinophilous character, finally fading into the mucigenous border of the surface epithelium. In these cells, as Bizzozero¹⁹ observed, the mitoses are more frequent than in the neck cells.

There is some evidence that the indulinophilous cells of the neck of the gland

(17) *Journal de l'Anatomie*, etc. No. 5. 1887.

(18) *Archiv f. Mik. Anat.* Bd. XXIV.

(19) *Archiv f. Mik. Anat.* Bd. XLII.

are young cells, which will ultimately grow down into the body of the gland, and take on the function of zymogenesis. This evidence will be offered in a later paper, in which also the regeneration of the surface epithelium will be discussed.

The discovery of the different nature of the cells in the neck of the gland affords a cytological basis for the division of the gland into two regions, called respectively, the neck and the body of the gland.

The length of the neck of the gland varies in the different portions of the stomachs of different mammals. I have not been able to demonstrate any change in the appearance of these cells in the different periods of digestion. In sections fixed in alcohol sublimate bichromate solution the branches of the lumen leading out to the border cells, as well as the fine intracellular secretion capillaries of the latter, may be perfectly seen.

The pyloric gland cells contain at no period of digestion either zymogen granules or prozymogen. They resemble closely in internal structure the cells of the middle portion of the neck of the fundus glands, and contain a similar secretion. As in the fundus glands, this stains intensely with indulin and Bordeaux R., and gives a faint metachromatic red stain with thionin. The reticulum observable in the indulinophilous portion of the cells is, as a rule, finer than in the neck cells of the fundus glands. Here, also, it may be observed that the indulinophilous cells pass, by gradual transition, into the mucous cells of the surface, and it is in the transitional portion of the gland that mitoses are most abundant, although they may be frequently seen even in the deepest portions of the glands.

The identity of the cells of the neck of the fundus gland with the pyloric gland cells in the cat may be demonstrated by a study of the so-called intermediary zone. Here I have found, not the mixed fundus and pyloric glands of other observers, but a gradual transition, brought about by the lengthening of the neck region of the gland, and the gradual disappearance, first, of the zymogenic cells, and finally, of the border cells, as the pylorus is approached.

CONCLUSIONS.

1. During digestion a substance similar in chemical properties to the chromatin of the nucleus makes its appearance in the outer clear zone of the chief cells of the fundus glands. This substance, which may be called prozymogen, stains deeply and readily in haematoxylin, and presents a characteristic fibrillated appearance. During rest this prozymogen is used up in some way, giving rise to zymogen granules.

2. The chief cells of the neck of the gland do not contain at any period of digestion, either zymogen or prozymogen, but are engaged in the formation of a mucinoid secretion, which has a powerful elective affinity for indulin and Bordeaux R., and stains metachromatically in thionin.

3. The pyloric gland cells, likewise, form neither zymogen nor prozymogen, and are similar in structure, in staining properties, and in the nature of their secretion to the cells of the neck of the fundus gland.

4. The cells, both of the pyloric glands and of the neck of the fundus gland, pass, by gradual transition, into the mucous cells of the surface, to which they are obviously closely allied.

THE NATURAL RESOURCES OF THE COUNTRY BETWEEN WINNIPEG AND HUDSON'S BAY: OUR NORTHERN OUTLET. BY LIEUT.-COL. T. C. SCOBLE.

(Read December 5, 1896.)

The area draining into Lake Winnipeg embraces 432,000 square miles, and includes the valleys of the Red, Winnipeg and Nelson Rivers, the overflows of Lakes Dauphin, Manitoba and Winnipegosis, and nineteen tributary rivers. The area of the Red River Valley alone is nearly 42,000 square miles, of which 7,000 square miles are within the Province of Manitoba, and constitute the home of the famous wheat known to commerce as "No. 1 Manitoba hard." The only impediment to navigation on the lower Red River is at St. Andrew's Rapids, where there is a fall of about fifteen feet, distributed over ten miles of the river, and this could be easily overcome by dredging. North-western Ontario, being the height of land, drains through the Winnipeg River into the lake at its south-eastern extremity, and the Great Saskatchewan, with its 1,513 miles of navigable channels, enters at the north-western extremity. Lake Winnipeg is 270 miles in length and 72 miles in breadth, from east to west, at the mouth of the Great Saskatchewan, its area being 9,400 square miles, or 2,070 miles larger than Lake Ontario. The precise elevation above sea level, Col. Scoble considers not yet determined, as authorities disagree. The average depth is from 42 to 90 feet, and there are few obstructions to navigation.

So far only two industries have been developed, those of lumbering and fishing. The spruce lumber cut annually in the Lake Winnipeg district amounts to about ten millions of feet, board measure; value, \$170,000. The fisheries in 1894 yielded 5,443,780 pounds, valued at \$188,014. The Inspector of Fisheries was quoted with regard to the inexhaustible supply of whitefish and sturgeon in these waters.

The geological formation is Laurentian on the east side and Devonian on the west side of the lake, showing that the dividing line between the two systems is covered by its waters. In some of the islands the two systems are in juxtaposition. On Black Island there is a most valuable deposit of soft brown hematite iron ore, yielding from 44 to 62 per cent. of metallic iron to the ton. Gold and silver are also found on the same island, with several other minerals of economic value. At Berens River and other points red hematite iron ore exists in vast quantities, and gold had been discovered on Bad Throat River and at Pipestone Lake on the Upper Nelson River. Beyond Lake Winnipeg north and eastward the whole country is intersected by lakes and waterways existing in the depressions in the Laurentian formation. The falls and rapids of the Nelson River were described in detail.

The boat route over which the Hudson Bay Company carried its traffic for over a century was next described, and the curious phenomenon of two rivers, one flowing east and the other flowing west from a narrow height of land only twenty-nine yards in width, was commented upon. Then the lecturer pointed out that the difficulties to be encountered in improving either of the two routes before described might be overcome by crossing the height of land to Molson's Lake. By this route out of a distance of 681 1-2 miles from Winnipeg to Hudson Bay, only fifty-seven miles would need any improvement to secure continuous seven-foot navigation, and of this distance only ten and a half miles would require canalling. Eight dams and thirty-four locks were all he estimated as being necessary in order to overcome the descent. No "locking up" would be required to get over the height of land, and the whole drainage area of the Winnipeg basin could be employed if necessary to develop the system. A mineral belt, similar to that of the upper Lake Superior system, crosses the country, and promises well to explorers.

The varied resources of Hudson Bay were described, and the question was asked, "Why should not these resources be exploited for the benefit of Canada?" American whalers had taken out millions of dollars' worth of oil and bone, and would continue to do so until Canadian rights were asserted. It was necessary in the interests of Canada as a whole, as well as for the North-West, that a new outlet to the ocean should be opened via Hudson Bay.

THE PANIS—AN HISTORICAL OUTLINE OF CANADIAN INDIAN SLAVERY IN THE EIGHTEENTH CENTURY. BY JAMES CLELAND HAMILTON, M.A., LL.B.

(Read December 12, 1896.)

- I. Examples of early American slavery among the Portuguese, Spaniards, and New Englanders. Story of Inkle and Yarico. Reference to panis in writings of Hennepin, Charlevoix, Colonel Landmann, and Captain Knox. Dr. D. G. Brinton, J. G. Shea, and Horatio Hale as to the Pawnees and Pani stock and their habitat. The New York and other early Colonial documents referred to.
- II. The Lower Canada records as to panis in cities of Quebec, Three Rivers, Montreal, and elsewhere. The punishment of slaves, the pillory, carcan and the rack. Panis in Montreal Hospital, in the seigniories.
- III. Legal position of Canadian slaves: The statutes, ordinances, and edicts as to them.
- IV. Panis in Upper Canada, at Niagara and Amherstberg. The Huron Treaty of 1764. The last pani.

I. The Portuguese in 1500 sent out an expedition to North America under Gaspar Cortereal, which entered Hudson's Straits. They brought away fifty-seven natives, to be sold as slaves and used as laborers.

The supposed excellent quality of these kidnapped natives, and the large supply which the country was likely to furnish, caused it, as our author alleges, to be called Terra Laborador, or the land of laborers, whence its present name (1). This seems to have been the beginning of the subjugation of aborigines on the North American Continent to slavery by Europeans and their descendants.

Before this the Spaniards had been active in Hayti and Jamaica in reducing the natives there to servitude, working them in the mines, and exporting many to the home slave market. In 1498 Christopher Columbus sent 600 of the natives to Spain and wrote as to them in impious blasphemy: "In the name of the Holy Trinity there can be sent as many slaves as sale can be found for in Spain, and they tell me 4,000 can be sold." He is said to have repented of his cruelty after being in turn sent to Spain in chains by Bovadilla. Tennyson makes him thus bemoan his fate, and theirs:—

"Ah God, the harmless people whom we found
In Hispaniola's island paradise—
Who took us for the very gods from heaven,
And we have sent them very fiends from hell.
And I, myself, myself not blameless, I
Could sometimes wish I had never led the way."

The Spaniards' cruelty in the Antilles was only paralleled by their conduct toward the natives of Mexico. The enslavement of red, as well as of black men,

(1) History of Nova Scotia and other British Provinces, by James S. Buckingham, p. 168. Other derivations have been given, but the above seems appropriate and well founded.

was not unfamiliar to even the Puritan Colonists. In 1675 many towns, villages, and farmsteads in Massachusetts and Rhode Island were destroyed by the Wampanoags, under the famous King Philip.

There were few families in the region attacked who did not mourn some of their members. When Philip had fallen, his chiefs, sachems and bravest men were put to death; the remainder were sold as slaves.

The son of Philip, whose only crime was his relationship to this great chief, was among the prisoners, and was sent as a slave to Bermuda, whence he never returned. An attempt to supply such labor for the New England home market led to speedy repentance.

A New Hampshire Provincial Law of 1714 recited that notorious crimes and enormities had of late been committed by Indians and other slaves within Her Majesty's plantations, and forbade the importation of any Indians to be used as slaves.

Washington Irving was among the first who criticized the stern and cruel features of the Puritans. They, he cried, trained the Indians for Heaven and then sent them there (2).

The story of Inkle and Yarico, as told by Steele, and familiar to all readers of *The Spectator*, illustrates the cruel practice of Europeans of the seventeenth century in treating all persons of darker complexions than themselves as proper subjects for barter.

Young Inkle, an English merchant adventurer, wanders from his ship on the American main, is found and saved by Yarico, an Indian girl, with whom he lived in tender correspondence for some months, when both escaped on a passing ship bound for Barbados. Here, as each vessel arrived, there was an immediate market of the Indian and other slaves, as with us of horses and oxen. The prudent and frugal young Englishman sold his companion to a Barbadian merchant. Had Yarico been carried to the old Province of Quebec she would have been called a *pani* (3).

From these instances of native American slavery beyond our immediate borders, we pass to consider how far such a system obtained in Canada.

Canadian negro slavery has been before described, (4) and reference is now made to the enforced servitude of red men in the French Province of Quebec, and the later Provinces of Lower and Upper Canada.

The Recollet Father, Louis Hennepin, was with LaSalle in 1679, and, writing at Niagara, says: "The Iroquois made excursions beyond Virginia and New Sweden * * * from whence they brought a great many slaves." (5)

A vessel, called "the Griffin," was built on Lake Erie, and in this these early adventurers crossed through that lake, the River St. Clair, and Lake Huron to Mackinac, where LaSalle parted from Hennepin, the vessel having been, meantime, lost in Lake Huron. Hennepin professes to have gone down the Mississippi, and to have been the hero of many wonderful adventures. This part of the story is questioned by Mr. Shea and others, but such details as Hennepin did not personally witness are, no doubt, taken from LaSalle's Journal, and are substantially correct.

As the Pawnee nation had its habitat on, and west of, the Missouri, we do not find them or their relations, the Caddoes, Wichitas and Huecos, mentioned in this interesting volume. It is stated that the Illinois Indians were accustomed to make

(2) As to Indian Slavery in the United States see Kent's Commentaries, part vi., lec. 61. and the authorities there cited. Winthrop's History of New England, vol. i. pp. 192 to 237. In Carolina hostilities were fomented among the tribes in order to purchase or kidnap captives and sell them as slaves to the West Indies. The sale and slavery of Indians was deemed lawful and the exile and bondage of captives in war, of all conditions, was sanctioned by the sternest Puritans. Bancroft's History, i. pp. 41-182. The war with the Pequots in 1637, and the confederacy of Indian nations in 1675 by Metacom, Sachem of the Wampanoags, commonly called King Philip, would seem to have been formed for protection and through patriotic views. Chalmers' Political Annals, p. 291. Indian Slavery ceased in Virginia only in 1705. Magazine of American History, vol. 21, p. 62.

(3) *The Spectator*, No. 11, March 13, 1710.

(4) Transactions of Canadian Institute, 1890, vol. i, p. 102.

(5) Louis Hennepin's "Discovery of America," cap. 18, pp. 19-37.

excursions far to the westward, and bring slaves from thence, which they bartered with other nations.

The southwestern Indians raided by the Illinoisans may be inferred to have been Pawnees. From their captors they passed to the white settlers in French Louisiana and Quebec.

Forty years after La Salle's time, intercourse between Louisiana and Quebec became comparatively common, and families coming up by the Mississippi, brought their negro and pani slaves with them.

Charlevoix, who visited Canada in 1721, refers to a nation settled on the banks of the Missouri, from whom persons taken captive were made slaves. He remarks: "The Arkansas River comes, it is said, from the country of certain Indians, who are called Panis Noirs—I have a slave of this nation with me (6)."

Next in date, refer to the story of the adventures of Alexander Henry, the fur trader at Michilimacinac in 1763, when that outpost of Canada was taken and the garrison massacred by the Chippewas and Sacs, he was led to a hiding-place by a faithful pani slave woman, and ultimately escaped. Her owner was Charles Langlade, a French halfbreed merchant and interpreter, and afterwards one of the early settlers in Wisconsin, but her name is not given. The Sacs and Chippewas were then at enmity with the Pawnee nation, and made slaves of such of them as they captured (7).

Colonel Landmann relates that, in 1800, when journeying from Amherstburg to St. Joseph's Island, he found a large Indian camp in busy preparation for the burning of a female prisoner, with a child at her breast. The usual horrors of torture had begun, and death was threatened, but the woman, in stoicism only expected from the other sex, was apparently indifferent to all. The Colonel negotiated for the purchase of both mother and child, and secured them in consideration of six bottles of rum, "that is," writes the careful chronicler "two of rum, mixed with four of water." The woman showed no apparent feeling, nor did she express thanks for her delivery from a terrible fate. This was but a part of the stoic manner of her race. She told all to her people, and before the young officer left St. Joseph's Island, a number of the woman's relations came and, to show their gratitude, made a considerable present of the finest skins they had been able at the instant to collect. The woman and child so saved were Pawnee captives (8). The Capitulation at Montreal had taken place on the 8th of September, 1760, and we find the word pani used in its 47th section, which provides that the negroes and panis of both sexes should remain in their condition of slavery, and belong to their French and Canadian masters, under British rule, as they had been before under the French regime, and that the masters were to be at liberty to retain them or to sell them, and to train them in the Catholic religion, except those who had been made prisoners of war.

Captain Knox visited Canada soon after this, and, commenting loosely on this section of the treaty, states his belief that panis imply convicts condemned to slavery (9). He gives no authority, and is entirely mistaken. This is the more to be regretted as others, assuming to write Canadian history, have copied his remark, traducing the character of the humble, early servant of the old Canadian homesteads. It is also remarkable that the part occupied by them in the social fabric has not been introduced into books of fiction and other writings descriptive of the seigniorial times.

May we not have a gentle Yarico, taking the place of Briseis or Helen, in an epic of the old regime; or even the story of a devoted Friday?

The stately mansion of Belmont, overlooking the St. Charles, home of the

(6) Charlevoix' Journal, vol. 3, pp. 212 and 410.

(7) Henry's Travels, part 1, cap. 10. Parkman's Conspiracy of Pontiac, vol. 1, cap. 18.

(8) Adventures and Recollections of Col. Landmann, vol. 2, cap. 6.

(9) Historical Journal, vol. 2, p. 428.

brave bourgeois, Philibert ; the manor house of Tilly on the shores of the St. Lawrence ; the Chateau of Beaumanoir, famous for the bacchanalian revels of the intendant Bigot ; the castle of St. Louis, and other "Seats of the Mighty" in New France, have often been described, but who has pictured the little huts in their courtyards, of the negro and pani ?

Dr. Daniel G. Brinton says that the Pani stock was scattered irregularly from the Middle Missouri River to the Gulf of Mexico. The Pawnees proper occupied the territory from the Niobrara River south to the Arkansas. The Niobrara River courses in an easterly direction through the northerly part of the State of Nebraska, and falls into the Missouri. The territory indicated embraces now the States of Nebraska and Kansas, and parts of Iowa and Missouri. It includes many cities and towns, among them being Des Moines, St. Louis, Topeka, and Omaha. The Arikari and Skidi branches of the nation separated at an early date and went north, while the Wichitas, Caddoes, and Huecos roamed over Eastern Louisiana and Western Texas.

The Pani stock, as a rule, had an excellent physique, being tall and robust, with well-proportioned features, the lips and eyes small. Their marriage customs were lax ; agriculture was more in favor with them than generally on the plains. Their religion somewhat resembled that of the Mexicans, and indicates a southern origin. One of their divinities was Opirikut, who represented the deity of fertility and agriculture. At the time of corn planting, a young girl, usually a captive, was sacrificed to this divinity. The victim was bound to a stake and partly burned, her breast was cut open, her heart was torn out, and flung into the flames. Her flesh was then divided into small pieces and buried in the corn field, to secure an abundant crop. In Mr. Grinnell's book this divinity appears under the name of Ti-ra-wa, and this sacrifice seems to have been most used by that portion of the nation known as the Skidi, whose home was on the Platte and Loup Rivers in Nebraska.

In 1806 the Pawnee tribe had a population of 6,223, with nearly 2,000 warriors. The Caddoes were of the same stock, and were also numerous on the western plains. "Since the removal of these people to reserves, mostly in the Indian Territory, the evidences of their progress towards civilization are cheering ; but their character has changed. In the old barbaric days they were light-hearted, merry, makers of jokes, keenly alive to the humorous side of life. Now they are serious, grave, little disposed to laugh. Then they were like children, without a care. Now they are like men, on whom the anxieties of life weigh heavily. Civilization, bringing with it some measure of material prosperity, has also brought care, responsibility, repression. No doubt it is best, and it is inevitable, but it is sad, too." Recent information as to the remnant of this nation is given by Mr. Geo. B. Grinnell, from whom we have just quoted. Many of the young men were embodied into companies of armed scouts, under Major North and other officers, during the construction of the Union Pacific Railway in 1863, to guard against the depredations of the Sioux and Arapahoes. They were brave and reliable soldiers, and it is to be regretted that the tribe of Pawnees proper is reduced to a few hundred souls, while the whole Caddoan or Pani stock does not probably exceed in number two thousand. (10)

The American Cyclopaedia, article Pawnee, describes the tribe as warlike, long resident in Nebraska on the Platte River and its tributaries. The name Pawnee or Pani is from the Illinois language, and is said to be from Pariki, meaning a horn, referring to the peculiar scalp lock, dressed to stand erect and curve slightly back like a horn ; the rest of the hair was shaven off. They were constantly at war with the Sioux and other nations, and, being considered irreclaimable savages, were permitted to be held as slaves in Canada, when bought from other tribes ; wherefore,

(10) U.S. Bureau of Ethnology, Vol. 7, pp. 61, 62 and 113, date 1885-6. "The present number of the Caddoan stock is 2,259, settled in Fort Berthold Reservation, N. Dakota, and some on the Indian Territory, some on the Ponca, Pawnee, and Otaw Reservation, and others on the Kiowa, Comanche and Wichita Reservations." They are now self-supporting.

any Indian held in bondage was called a panis. As to this our worthy and renowned Canadian ethnologist, Mr. Horatio Hale, writes me: "Panis and Pawnee are undoubtedly the same word, in different orthographies." He states that the article last quoted is from the pen of J. G. Shea, the distinguished ethnologist, and editor of *Charlevoix*: "All that he wrote on Indian matters is of the highest authority—what Mr. Brinton writes is also entirely trustworthy." "The Pawnees were true Ishmaelites. They had no friends upon the prairies, save those they had conquered and held by fear (11)." In addition to the Pawnees, there was certainly another tribe which contributed slaves to Canada (12). In 1712 the Renards, or Foxes, endeavored to capture and destroy Fort Detroit, but were defeated and compelled to surrender at discretion. Those found in arms were massacred, the rest were distributed as slaves among the victors.

There are a few references in the New York Colonial Documents to panis, or to Indians enslaved by whites. A narrative, presented to the Mayor's Court of New York City, 24th January, 1689, complaining of the violent acts of the Lieutenant-Governor, Jacob Leysler, states that an Indian slave of Philip French was, by him, dragged to Fort William on the 23rd of the previous December, and there imprisoned, but French was himself arrested by order of this bold Governor, and spent his Christmas in durance, for various matters of alleged contempt to His Honor. (Vol. 3, 676.)

Colonel Heathcote reports to Lord Townsend, British Colonial Secretary, July 16th, 1715, that the Indians complain that their children, who had been bound out for a limited time to be taught and instructed by the Christians, were transferred to other plantations and sold for slaves. He adds, "And I don't know but that there may be some truth in what they allege." (Vol. 5, 433.) M. La Galissoniere's Journal of events in Canada, under date Nov. 11, 1747, says: "The four negroes and a panis, who were captured by the English, would be put on board a small vessel bound for Martinico, to be there sold for the benefit of the proprietors." (Vol. 10, 138.) Colonel William Johnson writes to Governor Clinton, of New York, 22nd January, 1750: "I am very glad your Excellency has given orders to have the Indian children returned, who are kept by the traders as pawns or pledges, as they call it, but rather stolen from them, as the parents came at the appointed time to redeem them, but they sent them away before hand, and as they were children of our friends and allies, and if they are not returned next spring it will confirm what the French told the Six Nations, viz.: that they are looked upon as our slaves, or negroes, which affair gave me a great deal of trouble at that time to reconcile. I cannot find that Mr. Abeil, who has a Seneca child, or Vandrieson, who has got a Missisagey, are to deliver theirs, which I am apprehensive, will cause a great disturbance." (Vol. 6, 546.)

We find references of a similar character in the diary of David Zeisberger, the good Moravian missionary (13). He was loath to believe that such cruelty was practised, and ascribed the stories he heard to "lying rumours." Yet it is clear that these were well founded. Writing in 1795 at Fairfield-on-the-Thames, now known as Moraviantown, Ont., he says: "We had many lying rumours which the Indians hatch out, that the Indians here are entrapped by the white people, and will not be let go until they have all been sold as slaves. . . . The Chippewas have war with the North-western Indians. They have brought into Macinaw one hundred prisoners, a part of whom they sold to the whites. This is a nation with which they have waged war for many years." (14)

II. Next refer to the records in the old Province of Quebec relating to Panis. For these we are mainly indebted to the Abbe Tanguay's researches, made and

(11) "Pawnee Hero Stories and Folk Tales," by Geo. B. Grinnell, 1889, p. 307.

(12) McMillen's History of Canada, p. 91.

(13) Diary of David Zeisberger, by Eugene F. Bliss, published by the Historical and Philosophical Society of Ohio, 1885, Vol. II., pp. 411 and 491.

(14) A Travers les Registres, Montreal, 1886.

published in 1886 under the Quebec Government. In the church registers at the City of Quebec, under date 1718, it appears that "in the course of that year several Panis, being introduced from Louisiana, being slaves of Quebec families, were baptized."

In 1730 and following years the Church registers of Three Rivers contain records of baptisms and burials of several such slaves belonging to the principal families of the town.

November 4, 1756.—"Marie Judith, âgée de trieze ans, a ete baptisee," appears on the register of the parish church at Longue Pointe.

January 22, 1757.—A record shows that a pani slave called Constant, belonging to Madame de Saint Blain, was condemned to the punishment du carcan, and to be perpetually banished from Montreal. The mischievous character of this red woman was fully equalled by a negro slave of Madame de Francheville, who, in 1734, caused a great conflagration which destroyed part of Montreal. This negress was born in Portugal, and purchased by her mistress in New England. She was subjected to severe examination ("a la question ordinaire et extraordinaire"), when, it is stated, she confessed her guilt. (15) These cases are mentioned together, as they seem to be the only instances on the published records of such slaves being punished through the courts of Quebec; nor do panis appear on the Civil Court records, though their darker companions' names are often to be found there.

The carcan was an iron collar, placed around the neck, and connected by a chain to a post or to a wall, so compelling the prisoner to stand for a stated time, often for long, weary hours, in a strained position, and subject to ridicule. It was similar to the English stocks.

"La question extraordinaire" was the French name for the rack. These modes of punishment were not abolished in France until 1832.

We will now look at the records of the Montreal General Hospital, and we find, in a table prepared by the Abbe Tanguay, of families possessing slaves of the nation of the Panis that seventy-nine such slaves died in that hospital between 1754 and 1799. The birth, age and time of death of each are here given, and we have a record full of interesting facts and suggestions. Each poor slave has his or her Christian name, and the names were evidently given when the rite of baptism was performed. Mons. De la Verandrie had two, Joseph and Marie. Saint Luc la Corne had his Pani, Marie Joseph, who died in 1799, aged 100 years.

Among the masters were some gentlemen of aboriginal stock, or connected with Indian missions: M. Perthuis, interpreter of the Iroquois; De Quiensek, chief, and De la Garde, missionary to the Algonquins. (16)

Seigniorial, or well-known, families are represented in the masters, Deschambault, De Bleury, Chevalier de la Corne, De Veaudreuil, Benoit, Desriviers, Perigny, Reame, Decharme, Dames Deslignery and Monier, Messrs. De la Ronde, Delisle, De Longueil, La Coste, Leschelle, Senneville, De Barne and Clignanceur.

There is nothing in the record relating to the origin of these Panis except in regard to the last two, when we find that M. Gamelin had Jacque Cesar and M. Longueil had Marie both put down as Panis noirs, or black Indians of the plains, who were of darker hue than those in wooded lands. This being a distinctive term, places them as derived from the Pawnee nation proper, as designated by Charlevoix.

The Montreal newspapers of 100 years ago had occasional advertisements as to runaway slaves, and these were adorned with wood cuts representing the lost chattel. When a negro was wanted, he was shown running with naked body, save a cloth around the waist. The Pani was represented standing erect, with a feather head-

(15) Abbe Ferland's History of Canada, Cap. 29.

(16) Holding captives as slaves was, as is well known, common with the Indians. The Cherokees and Choctaws also had many negroes in bondage. There are some instances in Canada of red men holding blacks. The most notable of these was Colonel Brant Thayendinagea, who had several, among them being his body-servants, Patton and Ganseville, referred to in the writings of travellers such as Colonel Landmann and the Duke de Liancourt.

dress standing upright and a feather waist-covering, the body tattoo-marked. This comical figure, whether by accident or design, coincides with Mr. Grinnell's description of Pawnee Picts, or tattooed Pawnees. Rollin Michael Barrin, Count de la Gallissoniere, above mentioned, was Governor of New France, and a gentleman of scholarly taste and refinement. He is one of the leading characters in Mr. Kirby's excellent story, "The Golden Dog," the opening scene being laid in Quebec in 1748. Among the masters of Panis is the name of De Veaudreuil, who succeeded as Governor, and of the Chevalier la Corne St. Luc, a gallant soldier, who remained after the capitulation, and became a loyal defender of British rule. Other names, such as Benoit De Longueil and La Coste, are familiar to all readers of Canadian history.

Some months ago a worthy member of the Canadian Institute, with a handful of ashes from an ancient kitchen-midden, by means of a microscope brought up the Huron inhabitants and their surroundings as they were when Champlain unfolded the fleur-de-lis on the Georgian Bay. Our attempt is now, with these disjointed historic fragments from the ashes of time, to produce for development some features of these humble persons, the domestic slaves, and of their surroundings in those grand old times, when slavery was a thing of course and the seigniorial tenure most flourished in the old regime. The Panis no doubt spoke in a patois of French and Illinoisan. His dress was a rude commingling of the styles of Quebec and the wild South. He had no taste for work at the tail of the plough, but supplied venison and fish, made bows and lacrosse sticks for the boys, and joined them in games and hunting. The squaws waited on table, were the ladies' maids, the children's ayahs, and fashioned moose-skin moccasins, adorned with bright-tinted quills of the bristling porcupine. Removed from his native wilds, the Panis doubtless followed, to some extent, the religion of his masters, with its rites and ceremonies. But when he gazed on the rising sun, away from the presence of the Black-robe, we may imagine him imploring the protection of the dread Opirikut, god of his fathers; and when, in the winter evenings, the aurora flashed across the vault above, he saw the spirits of his friends in flight from the far south land, and then his heart filled with longings for the banks of the Niobrara, where the ancestral tents were set and the buffalo shook the plains.

With such suggestions, names and facts as have been placed before us, it only needs the wand of imagination to raise the curtain of six-score years and show the home of the seigneur among his habitant friends and neighbours beside the St. Lawrence, the St. Francis or the Chaudiere. And when there comes that happiest hour of the day, when the work is done and the night as yet is young, they gather into the great room, beech logs blaze and cast their light on bronzed features as they enter, capotes are thrown back, waist-sashes loosened, and the snow is shaken from homespun coats and deerskin leggings. Pleasant greetings and kind enquiries pass around, and the news of the day is exchanged. The cure, the seigneur and the notary sit where all can see and hear. In and out flits on moccasined feet a dusky figure almost unnoticed, yet not unwelcome. He quiets barking dogs, brings a coal to light a pipe, or stirs the logs to a fresh blaze. He is the Indian slave, the panis.

III. The edict of Louis XIV. in 1688, authorizing the importation of slaves from Africa, referred only to negroes.

Some doubt seems to have existed as to the legal status of panis, and, to remove these, Jacques Raudot, Ninth Intendant, issued an ordinance at Quebec on April 13th, 1709, referring to negroes and the Indian people called Panis, and declaring, "We, therefore, under the good pleasure of His Majesty, order that all the panis and negroes who have been bought, and who shall be purchased hereafter, shall belong in full proprietorship to those who have purchased them as their slaves." Then followed an injunction, prohibiting the slaves from running away, and provisions for imposing on those who aided them in so doing a fine of 50 livres.

Hocquart, Intendant under the Marquis de Beauharnois, Governor-General,

in 1756 issued an ordinance, declaring null all enfranchisements not made in compliance with certain regulations, and registered.

A declaration of the Paris Royal Council of 23rd July, 1745, declared that slaves who follow the enemy to the colonies of France, and their effects, should belong to His Most Christian Majesty.

This was a precedent of General Butler's famous order, made more than a century later, confiscating slaves coming into the Union ranks as "contrabands."

The Parliament of Great Britain was, when Canada was secured to the Empire, very favourable to the importation of slaves into the plantations, and had passed many Acts to aid that object.

Proceedings in the Montreal courts towards the end of last century tended to weaken the master's claims, and ultimately entirely broke them, with more regard to the rising public sentiment in England and France against slavery than to the actual state of the law, as has been shown in our previous paper. (17)

A census taken in 1784 states the number of slaves in Lower Canada at 304, of whom 212 were in the District of Montreal, 88 in that of Quebec, and 4 in Three Rivers. No distinction is there made between negroes and panis. An attempt was made in the first Parliament of Lower Canada, in 1793, to obtain an Act similar to that passed in the Upper Canada House at Niagara, which would have declared all slaves then held, to be in bondage for life, and only given freedom gradually to their offspring; but this proposal, though warmly debated, was not successful. In 1799, and again in 1800, Mr. Papineau presented petitions from many inhabitants of Montreal referring to the ordinances of Intendants Raudot and Hocquart, also to the Quebec Act, maintaining the former laws and usages to the people of Canada, and also to an Act of George III., under cover of which the petitioners allege a number of slaves, panis and negroes, were imported (18). Bills brought in on these petitions were much discussed, but sentiment was against their object; the declaration of the rights of slave-holders, and they failed to pass into law—thus slavery disappeared from Lower Canada. (19) It practically ceased at this time in Nova Scotia also and New Brunswick. The Upper Province had no such judicial and legislative experience as Lower Canada in regard to domestic slavery. When separated from the Mother Province in 1791, civil rights, including the law and customs as to slaves, still held in force. The Upper Canada Act of 1793 passed without difficulty, and there was no enactment here between that and the Imperial Act, which freed the few remaining slaves in 1834. While slavery existed, its character was modified, and personal cruelty guarded against by the code noir and provincial ordinances. As for the Indian slaves, there was also sympathy through the fact that not a few of the inhabitants were connected with the tribes by marriage. Mr. Parkman says with much truth: "Spanish civilization crushed the Indian, English civilization neglected him, French civilization embraced and cherished him. (20)

IV. There are few instances of panis in Western Canada. That of Mr. Langlade, who saved the life of Henry, the trader, at Mackinac, has been referred to. By the second article of a treaty of peace and amity, made by Sir W. Johnson with the Hurons 18th July, 1764 (21), it is provided that "any English who may be prisoners or deserters, any negroes, panis, or other slaves amongst the Hurons, who are British property, shall be delivered up within one month to the commandment of the Detroit." It may be concluded that there were a considerable number of panis in this western region then.

(17) "De l'esclavage en Canada," by Sir L. H. Lafontaine, *Proceedings of Societe Historique de Montreal*, 1858, and "Slavery in Canada," by J. C. Hamilton. *Transactions of Canadian Institute*, 1890. Vol. I., p. 102.

(18) 14 Geo. III., cap. 83; 30 Geo. III., cap. 27.

(19) *Journal of 1799*, p. 123, and of 1800, p. 51.

(20) "The Jesuits in North America," p. 44.

(21) Mr. S. White has the original treaty, but for copy see N.Y. Colonial Documents Vol. VII., p. 650.

In The Niagara Herald of 25th August, 1802, Charles Field forbids all persons harbouring his Indian slave, "Sall." Old residents of Essex County remember a pani who lived at Amherstburg fifty years ago.

Mr. Solomon White, lately member of the Legislative Assembly for Essex, is one of those who speak of him. When a child Mr. White saw "a little yellow man" at church, and he asked his mother who he was. "That is Mr. Caldwell's pani, Alexander," she answered. Though set free in 1834, he continued generally to reside at the old homestead, near the banks of the beautiful Detroit river. Here he was content to stay, passing an humble, happy existence.

There were many coloured people formerly slaves in the neighbourhood, and not far away was a settlement of the Hurons, but he preferred to look on the face and follow the footsteps of his old master, the late Mr. John Caldwell, enjoying the same civilization and religion. He died when on a visit to Detroit. His faith was that of his white protector, and his hope was, not to go to any happy hunting ground of his savage ancestors, but to participate in the white man's future. With him passed from Canada the last of the panis.

(22) As to Indian slavery in the south-west, see Mr. Lucien Carr's "Mounds of the Mississippi Valley," Smithsonian Report, 1891, p. 532, quoting "Narrative of Father Marquette," p. 32, and "Memoir of the Sieur de Tonti," pp. 56-71. "The Saukie warriors generally employ every summer in making excursions into the territories of the Illinois and Pawnees, from whence they return with a great number of slaves." As to sun-worship among these Indians, Mr. Carr states, p. 549, "According to Charlevoix the Indians claimed to have received the calumet from the Panis, to whom it had been given by the sun. . . . In trade, when an exchange has been agreed on, a calumet is smoked in order to bind the bargain, and this makes it in some manner sacred. . . . The Indians, in making those smoke the calumet with whom they wish to trade or treat, intend to call upon the sun as a witness, and in some fashion as a guarantee of their treaties, for they never fail to blow the smoke towards that star." The Sieur de Tonti describes temples dedicated to sun-worship, met in the course of his trip with La Salle down the Mississippi, A.D. 1682, one such temple was like the cabin of the chief, except that on top of it there were the figures of three eagles which looked toward the rising sun. It was forty feet square, and the walls ten feet high and one foot thick, were made of earth and straw mixed. The roof was dome-shaped, about fifteen feet high. Around this temple were strong mud walls, in which were fixed spikes, and on these were placed the heads of their enemies whom they sacrificed to the sun. These temples were found from Arkansas to the southern extremity of Florida, and in point of time they cover the 180 years between the expedition of De Soto and the visit of Charlevoix in A.D. 1721. When the Illinois came to meet Marquette on his voyage, the first ever made by a white man on the Lower Mississippi, they marched slowly, lifting their pipes to the sun, as if offering them to him to smoke.

(23) In P. Campbell's "Travels in North America in Years 1791-92," at p. 236, an account is given of adventures among the Ottawas. Campbell killed two Indians who had attacked him in his tent at night. He was soon after this made a prisoner, and said to his captors that he supposed they would avenge on him the death of the two Indians. He was answered that they cared little for what he had done, "that the men killed were not Ibawas but Pannees (sic), i.e., prisoner-slaves taken from other nations."

A PROBABLE SOLUTION OF THE SECONDARY UNDULATIONS FOUND UPON
SELF-RECORDING TIDE GAUGES. BY NAPIER DENISON, ESQ., TORONTO
OBSERVATORY.

(Read January 16, 1897.)

As this is the year set apart throughout the scientific world for special cloud observation and the study of the upper atmosphere as a means of improving the present methods of weather forecasting, and being one of those engaged upon this work for Canada, it seems an opportune time to bring the following investigations before the public :

In June last the writer's attention was first drawn to small, rapid changes of water level on Lake Huron, at the mouth of the river at Kincardine, where a rise and fall appearing to be regular, a set of observations with a temporary float were taken, and a uniform rise and fall of about three inches was found to occur, averaging nine minutes, that is about eighteen minutes for each undulation, the float moved up stream at the rate of a mile and one-half an hour. Upon returning to Toronto in July, by permission from Mr. Stupart, Director of the Meteorological Service, a simple instrument was devised to automatically record such oscillations, and set up at the mouth of the Humber River, where, ever since, most interesting results have been obtained. (1) By comparing these with the sensitive photographic barograph traces of the Observatory, it was found when a rise and fall of about four inches in water level occurred a corresponding, but slight change, in atmospheric pressure is noticeable; also a marked twenty-minute interval between these waves. To fully investigate this phenomenon another instrument, similar to that at the Humber, was placed at the Burlington Canal, and records from both instruments plotted, in conjunction with the barograph traces and different types of weather, as taken from the bi-daily weather charts:

It has been found, ever since the introduction of self-recording tide gauges throughout the world, peculiar oscillations within the normal tidal curves have been noted and commented upon, but to my knowledge, the cause not fully accounted for. These oscillations are most marked at tidal stations situated near the ends of bays, owing to the favourable configuration of the shore, and the shallowness of the water. They are not, however, of constant occurrence, but vary in intensity upon different days. Some months ago my attention was drawn to this peculiar phenomenon by a paper read before the Royal Society of Canada in May, 1895, by W. Bell Dawson, Ma.E., C.E., in charge Canadian Tidal Service, (2) who graphically demonstrated the existence of these secondary undulations, but left their cause unexplained. Thinking the above lake researches might help to solve the cause of these secondary tidal curves, through the kindness of Mr. Dawson, copies of the tidal records for Halifax, N.S., and St. John, N.B., were obtained for a number of days, including different types of weather. To fully investigate all the phenomena pertaining to these curves, days in succession were taken, chiefly those preceding and during stormy weather, for instance, the 5th, 6th, and 7th of February, 1896. These curves were plotted upon one-tenth inch squared paper, allowing one inch to the foot for Halifax, which has a range of about six feet, and one inch to five feet for St. John, which has a range of about twenty-eight feet, (3) and allowing one-tenth for every five minutes, being careful to minutely measure the extent and duration of every oscillation; above this was plotted the readings of the Halifax barometer, taken every three hours, also the hourly direction and velocity of the wind.

(1) A full account of these lake researches to be published shortly.

(2) Note on secondary undulations recorded by self-registering tide gauges. Vol. I., Sec. III.

(3) The St. John tidal curve is not included in above table, as only the most pronounced undulations are noticeable due to the reduced scale necessary where such high tides occur.

The following table gives a brief summary of results:—

Date.	Time.	HALIFAX, N.S.						Location of Storm Centre with Barometer Reading	Distance of Storm Centre from Halifax in miles.	Distance travelled during last 12 hours in miles.	REMARKS.
		Condition of Tidal Curve.	Atmospheric Pressure— inches.	Weather	Wind		Precipitation.				
					Vel.	Dir.					
1896. Feb'y 5th.	8 a.m.	Unbroken.	30.12	Cloudy	3	E.	0	over New Orleans (29.46)	1750	—	
" "	8 p.m.	Decidedly undulatory.	30.18	Cloudy	3	S.	0	over Montgomery, Ala. (29.30)	1475	275	From noon to 11 p.m. decided undulations throughout, but not exceeding .2'
" 6th.	8 a.m.	Most pronounced oscillations, often exceeding .4'.	30.23	Fair	0	0	0	over Lynchburg, Va. (29.00)	1000	475	Barometer rising until 6 a.m. 6th, wind calm from 1 to 6 a.m., gradient for easterly gale extending to Boston.
" "	8 p.m.	Ditto.	29.90	Lt. Rain	26	S.	R.	over New York City (28.70)	580	420	Barometer falling rapidly, gale extending to Halifax. Grand Manan, in the Bay of Fundy, reports 60 miles per hour.
" 7th.	8 a.m.	Amplitude of oscillations about .6'	29.08	Foggy	10	SW.	1.22	North of Portland, Me. (28.90)	300	280	Maximum oscillations from 1 to 6 a.m., ranging from .8' to 1' with an average interval of 20 minutes; also time of max. vel., 41 miles from S. and S.E.
" "	8 p.m.	Oscillations diminishing.	29.02	Cloudy	20	NW.	.10	Magdalen Islands (28.90)	330	400	Curve almost unbroken by midnight, a moderate gale still blowing from the N.W.; at time of forenoon high tide the curve was 1½ feet above normal.

From the tabulated data and the other tidal curves, studied in connection with the bi-daily weather charts, which bear out the increase of oscillations preceding the approach of atmospheric depressions, it appears that these secondary undulations are due to atmospheric waves or billows set up in the upper atmosphere.

We are told by the late Professor Von Helmholtz, (4) who has made a special study of these waves from theory and analogy with ocean waves, and has calculated their possible forms and dimensions, that "As soon as a lighter fluid lies above a denser one, with well-defined boundary, then, evidently, the conditions exist at this boundary for the origin and regular propagation of waves, such as we are familiar with on the surface of water. This case of waves, as ordinarily observed on the boundary surfaces between water and air, is only to be distinguished from the system of waves that may exist between different strata of air, in that in the former the difference of density of the two fluids is much greater than in the latter case. Since the moderate winds that occur on the surface of the earth often cause water-waves of a metre in length, therefore, the same winds, acting upon strata of air, say 10 degrees difference in temperature, maintain waves of from two to five kilometres in length. Larger ocean waves, from five to ten metres long, would correspond to atmospheric waves of from fifteen to thirty kilometres, such as would cover the whole sky of the observer."

Mr. Clayton, of the Blue Hill (Observatory (5) has graphically shown the coincidence and easterly progression of the larger atmospheric waves by means of the daily synchronous barograph traces from stations south and east of his, plotted upon the same time sheet, and has also shown that the maximum number of waves occur during a northeast wind, and the minimum when the wind is from the southwest, and that the greatest number were recorded during the winter months.

After referring to the above valuable investigations by two such well-known scientists, let us return to the foregoing table and frame a few leading questions, with the answers which appear to me most satisfactory. Further discussion will doubtless throw more light upon this subject.

1. Why do the secondary undulations become decidedly marked from noon of the 5th, although the barometer is steadily rising, and the wind at the earth's surface light or calm?

Because the upper part of the lower stratum of air, not being retarded by friction due to contact with the earth, and of greater specific gravity than that to the south and west of it, begins to move towards the region of lighter air, viz.: in a southwesterly direction, the barometric gradient being small, the movement is slow, but being in an opposite direction to the upper stratum, which is less dense, and rapidly moving polewards (mean winter rate, 112 miles per hour), (6) but inclined to the east. According to Helmholtz, this should be sufficient to produce along the boundary surfaces of the two strata, waves which may extend to the earth.

2. From 8:00 p.m., after the storm centre had passed to the north of Halifax, and a moderate gale still blowing from the northwest, why do the rapid undulations decrease until they almost form an unbroken curve by midnight?

The wind being westerly, a decided decrease of the undulations should be expected, on account of the lower stratum of the air, now moving approximately in the same direction as the upper layer, and as the force at the surface of the earth is still that of a moderate gale, greater velocities may be looked for at higher levels, where friction (viscosity not included), caused by contact with the earth, is inappreciable, thereby tending to equalize the easterly rate of movement of both strata; also well-defined boundary surfaces are not so likely to exist, owing to the more uniform temperature throughout both strata.

⁴ Paper read before the Prussian Academy of Sciences at Berlin, on July 25th, 1889, and translated in the Smithsonian Reports by Professor Abbe.

⁵ Blue Hill, Mass. Meteorological Observations. Vol. XL., Part III., Appendix E., 1893.

⁶ From Blue Hill cloud observations.

3. Why do the greatest number of atmospheric waves occur during northeasterly winds, and the least number with southwesterly winds?

A stratum of lower air, set in motion from the northeast towards the southwest, would be moving in an opposite direction to the upper or poleward stratum, therefore, the greater the velocity of the lower layer towards the westward, caused by the differences of atmospheric pressure, over the earth's surface, the greater will be the opposing forces at the boundary surfaces of the two strata, where great atmospheric billows may be found, especially when the densities vary greatly, caused by large differences of temperature between the two strata. The result would be similar to a high wind blowing against a strong surface current of water.

The minimum number of waves recorded during southwesterly winds is due to the lower stratum of air moving in the same direction as the upper, or poleward stratum.

4. Why do the greatest number occur during the winter months?

The winter being the time of the greatest differences of temperature between the equator and the poles, and consequently a more rapid movement of the poleward current, slight changes of velocity of the lower atmosphere tend to set up waves along their boundary surfaces, where, in all probability, greater differences of temperature exist than in summer. As in the case of an important storm centre moving northeasterly from the Gulf of Mexico, bearing large quantities of heat and moisture, while pronounced anti-cyclonic conditions, attended by great cold, prevail in the northern portions of the continent.

5. How can these atmospheric waves, which correspond to only a few hundredths or thousandths of the barometric inch at the earth's surface, cause such rapid and extreme oscillations as appear upon the tidal records?

The peculiar configuration of the coast line and varying depths of water, being the main causes of the different heights of the tides at separate stations, may we not apply the same to account for these peculiar oscillations, by asserting that the atmospheric waves or billows, in passing over the surface of the sea (in this case in the vicinity of Halifax harbour), tend to form minute undulations upon the surface, corresponding to the length of these billows, which, as they move farther into the bay, become magnified as they reach narrower and shallower portions, until finally they assume the proportions as found upon the tide gauge, a distance of about nine miles from the entrance to the harbour: That these oscillations do become more pronounced the farther one enters a long bay, have been noted by those in connection with tidal work. (7)

In conclusion, if the above explanations are correct, would it not be of great scientific and commercial value, in place of eliminating these secondary undulations, when tabulating the primary ones, to increase the amplitude of these secondaries, by lengthening the cylinder, use one sheet per day to prevent confusion of traces, and make a special study of them, respecting their intensity and time interval, in conjunction with synoptic charts during different types of weather? It appears as if these gauges are extra sensitive barometers, locally forewarning the approach of important storm centres many hours previous, in fact, during a rising or stationary barometer and before the shift of wind.

Improved tidal gauges of such construction are likely to be of incalculable value at all coast stations, more particularly by those on a western seaboard, such as that of the British Isles.

(7) Among others by Major Baird, R.E., F.R.S., *Manual for Tidal Observations*, 1886.

NOTE ON THE PUBLICATIONS OF THE CANADIAN INSTITUTE.

In 1852 The Canadian Institute began publishing its Proceedings under the name of "The Canadian Journal" in quarto. In this form it issued forty-one numbers, making three volumes.

In 1856, with the same name, the form was changed to octavo, in which size, up to 1878, ninety-two numbers were issued, making fifteen volumes.

In 1879 the name was changed to "Proceedings of the Canadian Institute," under which title twenty numbers were issued, in seven volumes.

In 1890 the publication was enlarged and the name again changed to "Transactions of the Canadian Institute." In this form, up to the present, nine numbers have been issued, making four volumes and part of a fifth. It is now proposed to issue two sets of publications, the "Proceedings" to contain short papers and abstracts of longer papers, to appear more frequently than hitherto, and as soon after the reading of the papers as possible. The "Transactions" to be issued at longer intervals and to contain such extended papers as it may be deemed proper to publish in full.

RECEIVED,

JUN 5 1897

PEABODY MUSEUM.

SOME LAPSED NAMES IN CANADIAN LOCAL NOMENCLATURE. BY REV.
HENRY SCADDING, D.D.

(Read November 28, 1896.)

It is a matter of some curiosity to notice the vicissitudes which have taken place, in several instances, in the names of places, rivers, and other natural objects, during our short history here in Canada. In some cases, names imposed by royal proclamation, or other competent authority, have failed to be used, or have been displaced by terms and titles, resting solely on popular usage. It may be considered a matter of some interest to recall some of these now disused, or, as we may say, lapsed names, and to review very briefly their history.

The name of our own capital, Toronto, itself covers a lapsed name, so to speak.

When first laid out as a town, Toronto, as we all know, bore the name of York, and was so known for a period of forty years. It was then, viz., in 1834, incorporated as the City of Toronto, which, singularly enough, was a return to a name which had lapsed, the locality having been for a considerable time previous to 1794, known by the appellation Toronto, of Indian origin. This, again, was a name, which there is good evidence to show, had fallen into disuse elsewhere, and had been adopted here. In the time of La Salle, 1680, the lake which we know as Lake Simcoe was known as Lake Toronto, while the site of our city was marked as Ti-ai-a-gon on the maps, a name which La Salle also employs. This word Ti-ai-a-gon, I am assured, signifies a landing, and it here denoted the landing place for voyageurs, bound for Lakes Toronto and Huron, via a trail or portage well known.

When the Wyandotte population, inhabiting between Lakes Toronto and Huron, was extirpated by the Iroquois, the name Toronto came to be gradually attached solely to its Ti-ai-a-gon, or landing place on Lake Ontario, where it survived. And here, again, we have a glimpse of another lapsed name.

The trading post at the landing had been officially named "Fort Rouillé," in honor of the then Minister of Marine of that name in Paris, but the popular use having become familiar with the word Toronto as applied to the landing, failed to adopt the expression, Fort Rouillé, and employed only that of "Fort Toronto" instead. Hence the survival of the beautiful word Toronto, hereabouts, to this day.

It may here be conveniently added that the neighboring Humber River is given in the first Gazetteer of Upper Canada, dated about one hundred years back, as "St. John's River," from a French settler named St. Jean, who had a wayside inn, or place of entertainment, at its mouth. "Humber" displaced a long and rather

uncouth Indian name, which appears on the maps ; at the same time "Don" replaced an equally unmanageable Indian name, describing the river at the eastern end of our harbour. The interpretation of these two lapsed Indian names I am not able at present to give, but doubtless they were both significant. At the same time that the names "Humber" and "Don" were imposed upon these two streams, the name "Nen" was, by authority, given to the next river to the eastward, previously known as the Rouge or Red River. "Nen," however, became a lapsed name, and the Rouge retained, and still retains, its original appellation. "Nen," like "Humber" and "Don," was the name of a river in Yorkshire. It was the evident aim of the authorities to Anglicise the river names, and the notable river, still known as the Grand River, entering Lake Erie from the north, was enjoined to be known only as the "Ouse," another Yorkshire river name ; but again popular usage prevailed, and "Ouse" became another instance of a lapsed name. "Grand River," of course, had nothing distinctive in it, and every river of a considerable size was, amongst the French, a "Grande Riviere." The Mississippi was so par excellence among the Indians, such being, in an emphasized way, the signification of that word.

A widely-received French appellation for our Canadian Thames was La Tranche, until forcibly over-ridden by royal proclamation.

More than one lapsed usage in regard to the River Niagara may be in place here. Wherever the name occurs in early English verse, the metre obliges us to make the penultimate syllable long in quantity, showing that such was the prevailing pronunciation at the outset. Further, it appears from the early records, that an O has been dropped off from the beginning of this word, as has happened likewise in the case of other Indian appellatives ; thus we have Miami and Omiami, Swegatchie and Oswegatchie, Chouegon and Ochouegon (the modern Oswego), Mimico and Omimico, Chippeway and Ochipway, Tessalon and Otessalon, and some others. So Niagara was once Oniagara, a form of the word now entirely lapsed. There is reason to think that a like clipping off of an O has taken place in "Toronto," together with the suppression of a final N. Sagard, in his Huron, or rather Wyandotte vocabulary, gives both "Toronton" and "Otoronton." The expression signifies a large quantity, whether of human beings or of provision for their sustenance, both O and N probably representing a nasal sound very familiar to us in former days, in Indian viva-voce utterances. Another substitution in modern times of a short A for a long one in an Indian name, seems to be shown in Moore's "Uttawa's Tide" (read Uttah-wa's tide) meaning the River Ottawa, the first syllable of which name he evidently caught as U and not O.

We are slowly becoming accustomed to the style and title of "Niagara-on-the-Lake," used in modern times for the purpose of distinguishing the old town of Niagara from what is now designated as Niagara South, meaning thereby Drummondville, which is expected hereafter to become a lapsed term, although, of course, it will take a long time to bring that about. Old Niagara might have fallen back upon a lapsed name of its own, viz.: Newark, the name borne by its site when the first Parliament of Upper Canada was held there. The place we now call Queenston was known aforetime as the "Carrying Place," the place of debarkation for the "Grande Portage" round the Falls of Niagara, in the voyageurs' route between Lakes Ontario and Erie. Another lapsed name for Queenston, in the same regard, was the "Lower Landing."

Burlington Bay, at the head of Lake Ontario, received that name by proclamation on July 16th, 1799. Previous to this date it had strangely borne the name of Geneva Lake ; so we are informed by the first Gazetteer of Upper Canada. The lapsed name, we may suppose, arose from the picturesque beauty of the sheet of water indicated.

On the north shore of Lake Ontario, close to Burlington Bay, a name has lapsed into disuse within the past few years. I refer to Wellington Square, now known as Burlington. The word "Square," I believe, referred originally to a square

tract of land granted to the Indian chief, Joseph Brant, at this spot. Wellington, of course, referred to the Iron Duke, but we already had a memorial of him in the name of the County of Wellington, in Western Ontario. A general name for Burlington Heights, and the whole range of high land on the west side of Lake Ontario, appears to have been "Dorchester Mount," when D. W. Smith's Gazetteer was constructed, but that expression has now long since ceased to be heard. A familiar name for the swamp now traversed by the Des Jardins Canal, leading from Burlington Bay to Dundas, was "Coote's Paradise," an expression now fallen into disuse. Coote was an officer in the regular army, an enthusiastic sportsman, who found in the wild fowl and other game frequenting this marsh a never-failing means of indulging his favorite pursuits.

Two grand thoroughfares were marked off and partially cleared out, at the very outset, through the Province of Upper Canada, one named Dundas street, and the other Yonge street. The latter continues as a well-defined highway, leading from Toronto to the Holland Landing, and thence virtually across the country, via Shanty Bay and Penetanguishene, to Lake Huron and the far West.

I fear the railway authorities are doing something to render Penetanguishene a lapsed name, or at all events, partially so. They are encouraging the practice of writing and printing "Penetang," instead of Penetanguishene." The name, thus mutilated, can have no complete sense, the whole word being descriptive of a landmark at the entrance to the Bay, consisting of a bank where the sands run down. (1)

Dundas street as a grand thoroughfare has, unhappily, not retained its name throughout. For a long time the whole route, from Chatham to Dundas, and thence to Toronto, was pretty generally known as Dundas street. The popular name for a portion of it, among settlers in the west was, for a while, and, perhaps may continue still to be, the Governor's Road, and it will be remembered, possibly, by many of us, that what is now called Queen street in Toronto, was, in its western portion at least, styled Dundas street, although "Lot street" was its more customary designation, as it passed on eastward to the River Don, from which point the leading thoroughfare became better known as the Kingston Road; but in well-engraved early maps the line of road eastward is to be seen marked as Dundas street, all the way to where it strikes the Ottawa, a few miles from the entrance of that river into the St. Lawrence.

The whole route from Chatham, in the west, to the Ottawa, in the east, was designated a street, with allusion to the great Roman roads (*viae stratae*), remains of which are traced everywhere in the Island of Great Britain and throughout the Continent of Europe—paved roads securing an easy transit for armies, arms and ammunition, and at later periods for merchandise. A noted instance of these is Watling street, reaching from Dover all the way to Chester, and passing through London, where a fragment of this same Roman highway is still known as Watling street. It is to be regretted, perhaps, that our "Dundas street" has become a lapsed term in so much of its route, but, happily, Yonge street still remains to us an interesting reminder of the past. On this street, six miles to the north of Toronto, "Hogg's Hollow" has been changed to the more euphonious expression, "York Mills." Of these mills, Mr. Hogg was the original builder and proprietor. Along the great thoroughfare, originally known as Dundas street, proceeding eastward from Toronto, we meet every now and then with lapsed names.

In connection with Toronto itself, two may be mentioned, in addition to those already given. The township in which the city stands was, and is still named York, but previously, strange to say, it seems to have borne the name of Dublin. Thus, in our old, oft-quoted Gazetteer, we have, at page 55. "Dublin, now called the Township of York; which see." No further explanation is given. It was expected, per-

(1) Other lapsed names besides "Lake Toronto" are covered by Lake Simcoe's present name. The French styled it for many years *Lac aux Claires* (Hurdle Lake), from some arrangement for the capture of fish at the Narrows, a name sometimes corrupted by the English into *Lac le Cle*. Two islands in this lake have likewise lost names once borne by them: Francis Island (so called by Governor Simcoe from the name of his son), and Darling's Island (commemorative of a favorite aide-de-camp of the Governor's), are now respectively known as Grape Island and Strawberry Island.

haps, to be attractive to the Irish settler, but it quickly became a disused term. Previous to the setting off of Upper Canada as a Province, the region about here had been known as the District of Nassau, and various localities to the eastward had designations sounding very German-like given them, such as Charlottenburg, Lunenburg, Osnabruck, etc. Such names were simply compliments to the reigning Hanoverian family, or might be expected to attract German settlers; but if not actually become lapsed terms, they have ceased to draw. The other lapsed name in connection with Toronto is "Gibraltar Point," meaning the western portion of the Island in front of Toronto, and having a humorous allusion to the solitary Block House, erected there for the defense of the harbour and protection of a commissary storehouse. "Gibraltar Point" has lapsed into disuse, although we still occasionally hear Blockhouse Bay for one of the inlets at the "Point."

On the lake front of the Township of Whitby there was, for a time, the town of Windsor, on Windsor Bay, where it appears, thus named, on the engraved maps of Canada a few years since. Windsor is now a lapsed name, obliterated, possibly, by the greater importance of the western Windsor on the Detroit River. Its site is included within the limits of the modern town of Whitby. In passing, it may be mentioned that the site now occupied by Port Hope is marked on some of the old maps *Ti-ai-a-gon*, which, as we have already seen, simply meant "a landing," this having been a distinguished landing place for Indians and voyageurs en route to the waters to the north, entitled by us Rice Lake. (2)

The name "Cobourg" is not, as might have been supposed, a survival of one of those German-sounding names prevalent in Canada just after the taking of Quebec. Like Guelph, it appears to have been a modern compliment to the reigning Hanoverian family. It alluded, probably, to the husband of the lamented Princess Charlotte, Prince Leopold of Saxe-Cobourg. The place, we are told, was for a short time good-humoredly styled "Hard Scrabble," by settlers near the locality, but this was simply a transient jest.

At Kingston we have to recall the now lapsed names of Cataraqui and Fort Frontenac. An attempted Latinized form of "Kingston"—*Regiopolis*—was for a time heard of in ecclesiastical quarters, but, mongrel as it was, between Latin and Greek, it is now dropped. As to the name "Bay of Quintè"—the original word was an Indian one—*Kentè* or *Kanti*. French pronunciation produced the form *Quintè*, conveying some notion of "five or fifth." While passing Gananoque on our way east, it should be recalled that, strange as it may sound, the river which enters here and bore the name of Gananoque, was at a very early period styled the Thames. This we learn from a proclamation by Lord Dorchester, better known as Guy Carleton, bearing date July 24th, 1788, wherein he speaks of a boundary line running north and south, and intersecting the mouth of the River Gananoque, now called "The Thames." This seems to have become a lapsed name at the time when the Province of Upper Canada was set off and separated from the old Province of Quebec, when the previous arrangement of the region into four distinct sub-divisions was dropped, and the terms District of Lunenburg, District of Nassau, District of Mecklenburg, District of Hesse ceased to be heard. The town of Cornwall, just below the Long Sault Rapid, was formerly known as New Johnstown, from the name of a neighboring township. For the inhabitants of Cornwall the lapsed name, New Johnstown, must, of course, possess some interest.

In regard to the Long Sault Rapids, Guy Carleton, in the proclamation just above referred to, makes use of a good English word, now fallen somewhat into disuse. He speaks of "rifts," meaning thereby interruptions in the navigation of the

(2) The river at Port Hope still bears the homely name of "Smith's Creek." The Indian name of the stream, rightly treated, would have had a finer sound. Major Rogers, in his journey westward from Fort Frontenac to Toronto, in 1760, passed two rivers bearing respectively the names of "The Grace of Man" and "The Life of Man," according to the somewhat fanciful translation which he gives of their Indian appellations. It is not easy to identify these streams, but Smith's Creek may have been one of them. "Lyons' Creek," a little to the west of Smith's Creek, was once known by an Indian name signifying "the river of easy entrance."

river. He describes the mouth of the River Gananoque as being situated "above the rifts of the St. Lawrence." In early maps of Canada and North America generally, the term rifts is to be seen at the several points of a river, where now we should see the word "portage" used, indicating thereby that the navigation at that point was interrupted by cataracts or dangerous rapids. Apropos of rapids, it may be subjoined that a certain swift portion of the St. Lawrence, not far from Cornwall, used to be designated by an English-speaking lumberman, "The Mill Rush," thereby barbarizing the neat expression, "Les Mille Roches," used by the French when speaking of the same spot in the river. The same lumberman has made Bobcaygeon out of some such Indian term as Baba-kad-juan, descriptive of the lockage between Pigeon and Sturgeon Lakes.

We now approach Montreal and Quebec. The Indian term for the former place is stated to have been Hochelaga, and of the latter Stadacona. These two can scarcely be termed lapsed names, as they still maintain a good standing in the primitive and poetic accounts of Canada. The ecclesiastical title of Montreal, *Ville Marie*, like that of *Regiopolis* for Kingston, is now seldom employed by the English-speaking portions of the community. The name of a town, situated at the mouth of the River Richelieu, on the St. Lawrence, a short distance from Montreal, must be mentioned. This is Sorel, which is another instance of the prevalence of popular usage over authoritative decrees. The name imposed on the spot by the English-speaking authorities was William Henry, a compliment to a Prince of the Royal Family, but the earlier French name of Sorel has survived, as being doubtless the fittest.

I here bring to a close my list, after all, not by any means perfect, of lapsed local names in Canada. To enter upon the changes that have taken place in street names in our cities and towns would be an undertaking too large for the present occasion. I cannot refrain from remarking, however, a usage which I observe to be growing, in regard to the name of one great, conspicuous thoroughfare in Toronto. A few years since it was universally known as Spa-dee-na Avenue. Dr. W. W. Baldwin evolved out of some such Indian expression as *Eo-pa-dee-nong*, the quite elegant and shapely name of *S-p-a-d-i-n-a* (pronounced by himself and all his belongings, *Spa-dee-na*). It denotes, I am assured, a rise of land, and has reference to the slight ridge which bounds the site of Toronto on the north side. A considerable portion of this ridge was owned by Dr. W. W. Baldwin, and here was situated his family residence, Spadina House, exactly at the extreme northern terminus of the great avenue, bearing to this day the fine, modified Indian title just spoken of, the polite pronunciation of which seems to be threatened, although it is to be confessed that Regina, Carolina, etc., certainly favor the innovation. Below the shield of arms on Dr. Baldwin's book-plate is to be seen "Baldwin, of Spadina, in the County of York, Upper Canada."

One word in regard to the names of two outside cities, with which, in Canada, we are sometimes brought into very near relations—Buffalo and Chicago. In some respects it seems a pity that these names have not lapsed and been replaced by others of a more becoming form, and nobler significance. Buffalo took its name, no doubt, from the accidental circumstance that the stream, at the mouth of which its first buildings began to arise, was named Buffalo Creek, in French, *Riviere des Boeufs*, that is, the river of the Buffalos or Bisons. If the word Buffalo had to be retained in the composition of the place-name, it should have been furnished with some customary prefix or suffix, to denote the fact that it was a place-name. We have, in classical geography, the city or town of Elephantine. The termination denotes that it was the city or town of the *elephas* or elephant. The founders of the place would have had scruples as to calling it *Elephas* (Elephant) pure and simple. So, another rather famous classical name—*Bucephala*—really meant the city of *Bucephalus*, that is, the city rendered famous as being the burial place of Alexander's steed, *Bucephalus*. It would have doubtless been thought very anomalous to have

called the place Bucephalus, wholly unchanged. The name of the city of Buffalo might have been a modification of the native Indian term for the bison or buffalo, showing, by an affix or final syllable, that it was the name of a place, and not of an animal. In regard to Chicago, the name, it is sad to say, intrinsically has a significance somewhat ill-savored. It involves as its root element the Otchipway Jikag, which denotes a polecat or skunk, as Baraga informs us in page 572 of his *Otchipwe Dictionary*, Cincinnati, 1853. If Chicago should ever become a lapsed name, it is to be hoped that its place will be taken by one constructed on an entirely different basis. We hear of this city sometimes as the Windy City. Let now good Otchipwe be found for Windy City, and let that be transformed by a committee of experts into a euphonious place-name for the great capital of Illinois.

THE ORIGIN OF THE SALISHAN TRIBES OF BRITISH COLUMBIA AND WASHINGTON. BY JOHN CAMPBELL, LL.D.

(Read January 16, 1897.)

So little of the nature of history attaches to the aboriginal races of Canada as to make a survey of them a mere study of the baldest anthropology. Yet even mere anthropology is not biology; its object is man possessed of a soul and a soul's record. It is hardly probable that a race has passed through the four thousand odd years of post-diluvian history without taking some part in its historic events. The modern Chinese are supposed to be the descendants of the ancient Babylonians. The degraded Yeniseians and the ambitious Japanese are equally derived from those Hittite tribes that conquered Egypt and overthrew Assyrian Monarchy. In Mexico, the native Aztecs or Nahuatl are most of what remain of the Nahiri of Mesopotamia, who contended in ancient days with the Thothmes and the Tiglaths; while Homer's Dardanians, the expelled Toltecs from that same American state, are now to be found in the aborigines of Peru. The records of the League, which we term the league of the Iroquois, are engraved on the rocks of the Sinaitic Peninsula, some of them in characters as old as the patriarch Isaac. Old inscriptions and old books tell part of these stories, but most of them lie hidden in language, in proper and common names, in grammatical constructions, as well as in legends and traditions of the past. Just as old families fall into decay and poverty by the misbehavior of ancestors, so nations that once ruled the world become pariahs; *exempli gratia*, Amalek, the first of them all, whose name now lives in the Amaligmuth of the Eskimo. There are very ancient families with far more than sixteen quarterings among our most degraded tribes.

I have looked into the antecedents of the Salishans, not because I know anything of them personally, but because they live largely on Canadian soil, and because I know their grammar, and can thus reason back into their past history. If you would like to become acquainted with the books that treat of them, get the late James Constantine Pilling's "Bibliography of the Salishan Languages," published by the Bureau of Ethnology at Washington, and Major Powell's "Indian Linguistic Families," in the report of the same bureau for 1885-86. If language be your quest, consult the vocabularies of Gibbs, Tolmie, and Mengarini in the first volume of "Contributions to North American Ethnology," published by the United States Geographical and Geological Survey of the Rocky Mountain Region; and "Comparative Vocabularies of the Indian Tribes of British Columbia," by Drs. Tolmie and Dawson, given out by the Geological and Natural History Survey of Canada. According to Major Powell, the Salishans of the United States number 5,500, and those of Canada, that is, of British Columbia, 12,325. Of the latter, the larger number are connected with the Fraser River Agency, but the Kamloops Agency overlooks over 2,500, and others report to the Williams' Lake, Cowichan, Okanagan, and Kootenay Agencies. Major Powell gives the names of no fewer than sixty-four septs or tribes belonging to this family. The earliest record of them is that of Alexander Mackenzie, in his "Voyages from Montreal Through the Continent of North America," published in 1801. On page 257 he gives a brief vocabulary of the Atnah sept, and, on page 276, a shorter one of the Friendly Village Indians. The Salishans have erroneously been called Flatheads, a term that applies to their neighbours, the Tsinuks.

In attempting to affiliate the Salishans, I rely altogether on language. It has two parts—the grammar and the vocabulary. Father Mengarini's grammar I have not seen, but the "Niskwalli Dictionary" of Dr. George Gibbs exhibits the Salishan grammatical system sufficiently for comparative purposes. That system is preposing. It makes use of prepositions, not of postpositions. It also places the governing word before its genitive, the adjective before its noun, the temporal index before the verb. In these and in other particulars, Salishan grammar is not that of Northern Asia, as are Iroquoian, Dakotan, Muskogean, etc., nor that of Melanesia as the Haidah is, but that of the Malay-Polynesian area. Seventeen years ago I exhibited, in a paper read before the Institute, the relation of the Algonquian dialects to that same Malay-Polynesian family. It is not easy to draw a line between what is Malay and what is Polynesian, either in grammatical forms or in vocabulary, yet the Algonquian dialects may be called more Malay than Polynesian. This appears most prominently in the word for man, which in Malay is *oran* or *ulun*, whence the Ilianoans of Borneo have their name. But in America, the Delawares are the *lenni Lenape* or the Lenape men, the State of Illinois was so called after the Algonquian *Illeni*, and the Micmac calls himself *ulnook*, a man. The Polynesian, on the other hand, terms himself *tangata* or *tamata*, and that seems to be the original of the Salishan *tamihu*, *tamekhw*, *tumikh*, *temokh*, *tobesh*, and *stobush*. If, therefore, a line is to be drawn between Malay and Polynesian, it may be inferred that the Salishans are more Polynesian than Malay.

In comparing the vocabularies, I have restricted myself, so far as the Salishan dialects are concerned, to the Niskwalli. This is not for lack of material, since I have vocabularies of over twenty other dialects, but for the sake of brevity and clearness. The Niskwalli is that of Dr. George Gibbs, and the Malay-Polynesian terms are taken from Crawford, Wallace, Belcher, Hale, and a variety of other sources too numerous to mention. The words compared are the commoner nouns and adjectives, a few verbs, the personal pronouns, the numerals, and some particles, altogether over 150 in number. The evolution of the Salishan term from the standard Malayan or Javanese is sometimes quite easy to follow, but in other cases my comparative vocabularies have failed to present all the links desired. Most of the distinctive Malay terms are conspicuous by their absence from the Niskwalli vocabulary, such as *kapala* head, *muka* face, *mata* eye, *talinga* ear, *idung* nose, *mulut* mouth, *lidah* tongue, *tangan*, *lima* hand, *langit* sky, *ayer* water, *api* fire. But there are many evident Malay analogies, as of the Niskwalli *kobatit* axe, to the Malay *kapak*; *toligwut* blood, to *darah*; *tus* cold, to *tijok*; *eluks* end, to *alos*; *ashuts* fear, to *coquet*; *silels* forehead, to *alis*; and *tsoks* seven, to *tujuh*. He would be a bold philologist who would identify the Niskwalli *skwallup* ashes, with the Malay *abu*; but *abu* becomes the Bali *habu*, the Sunda *labbu*, the Bouton *orapu*, and the Mysol *gelap*. A far more extraordinary metamorphosis is that of the Malay *kasih*, to give, into the Niskwalli *abshits*. It first becomes the Bali *sukahake*, then the Bisayan *maghatag*, next the Iloco *pannangted*, the Biajuk *manenga*, in another Bali dialect *bahang*, afterwards the Tagala *bigai*, the Tahitian *evaha*, the Hawaiian *hoatu*, and the Tobi *wacito*, which is not *abshits*, but is near enough to it for all practical purposes.

The Salishan dialects disguise their relationship with prefixes and affixes, the meaning of which is little known. Take, for instance, the words for moon and sun. The moon is *slok-walm*, in which the latter syllable is plainly the almost universal Malay-Polynesian *wulan*, *bulan*, *fulan*, *hulan*, the moon. The sun is *klok-watl*, and here again the second syllable is the Malay-Polynesian *mataari*, *matalo*, *watalo*, *batalo*, the sun. What *slok* and *klok* or *slo* and *klo* mean, the dictionary does not state. The peculiar progress from labial to sibilant and guttural through the aspirate effectually obscures the unity of roots. This is apparent in *chetla*, the

Niskwalli word for a stone. The Malay form is *batu*, the Timuri *fatuk*, the Javanese *watu*, the Fijian *vatu*, the Rotuma *hathu*, the Maori *kowatu*. But the *l* of *chella*, which otherwise might arise between *hathu* and *kowotu*, appears in the Biajuk *batro*, and, out of place, in the Malagasy *varto*. A strange word is the Niskwalli *stoduk*, a slave. Its original was the Malay *budak*, which assumes in Javanese the form *abdi*, recalling the Semitic *ebed* and *abd*. The *b*, thus made non-initial, dropped out in the Bugis and Macassar *ata*; and in the Malagasy *andavo*, at first, probably, after the fashion of the Bouton *otuko*, a post runner. Some other law of the permutation of letters than that of Grimm must be found to enable the student to trace out Malay-Polynesian derivations in America. The term for nose in Malay, Javanese, Madura, and Lampung is *idung*, *irung*, *elong*, *egong*. This is paralleled by the Cree of Moose Factory, the Plains, English River, and the East Main, whose relative word for man is *ililew*, *ininew*, *ithinew*, and *eyiyew*. The derivation of the Niskwalli *muksn*, the nose, from the Malay *idung* proceeds through the Lampung *egong*, the Bali *kunguh*, the Bugis *ingok*, the Bali ceremonial *hungas-un*, and the Samang *muk*, with the *san* of the preceding.

The Malay-Polynesian character of the Niskwalli numerals is incontestable, yet that denoting 5, namely *tsahats*, which means "the fingers," is utterly unrepresented by the various forms of *rima* and *lima*, which indicate the hand and five. It is probably derived with inversion of parts from the Tambora *roma-toha*, 5, answering to the Lariki *lima-hatu*, finger. Here *toha* and *hata* are governing words, and in true Malay-Polynesian, as opposed to Melanesian, order should stand first. The Tongan word corresponding to them is *cow*, and *cow-nima* denotes the fingers. Then the Tambora *toharoma* must by degrees have become *toharon* or *tohalon* and afterwards *tohalot*. In some vocabularies the Tambora word for five is given as *kutelin*, which is just an inverted form of the Lariki *lima-hatu*, with the *lima* fallen to *lin*. The Tidore *runtoha*, 5, exhibits the same phonetic decay, and restored to Malay structure, would be *toharun*. As *lima*, 5, becomes *lib* in one of the dialects of the Caroline Islands, *lin* might become *lit*, dental replacing dental in some other dialect. I confess, however, that I have not yet come across an instance of such conversion of *lima*, the numeral, within the limits of the Malay-Polynesian area. The nearest to it is the *lok* of the Lampung *chiu-lok*, the hand. To one conversant with Lower Canadian patois, who has heard *omelette* and *patate* pronounced as *omelaque* and *pataque*, the transition from *chiulok* to *ts-alats* will not appear strange.

The Salishan name is probably derived from that of the inhabitants of the Sooloo, or more correctly the Suluk, Archipelago, between Borneo and the Philippines, who are represented in the vocabulary by twenty-two words. The dialect under consideration, namely the Niskwalli, seems to be that of Mysol, which lies between Ceram and the north-western corner of New Guinea. It is represented by seventeen words, many of which closely resemble those of the Niskwalli. These might be largely increased. For instance, the Mysol name for man is *mot*, which in Salibabo becomes *tomata*. If, therefore, we find Niskwalli in Mysol, we may be justified in finding two other Salishan tribes, the Shwoyelpi and the Skoyelpi, in the people of the Salibabo Islands, between Gilolo and the Philippines. The *mot* of Mysol and the *tomata* of Salibabo furnish a beginning of the Polynesian word for man, as differentiated from the Malay, and that is the original of the Salishan term. The Mysol *motni*, belly, is probably the original of the Niskwalli *smukha*; *bit*, black, of *hitotsa*; *kachun*, boy, of *chachas*; *wai*, child, of *bibad*; *patoh*, cold, of *tus*; *yem*, dog, of *komai*; *gaf*, feather, of *stokw* (in Skoyelpi it is *stakapisten*, and in Salish proper, *skapussel*); *kanin*, hand, and *kaniuko*, finger, of *chalesh* and *shalatshi*, by *l* replacing *n*; *wamut*, flesh, of *beyets*; *kasebo*, finger-nails, of *kohwachi*; *gakawatu*, root, of *aspu*; *umblo*, soft, of *esmelin*; *jiyu*, wife, of *chugwush*; *lu*, two, of *salew*; *fut*, four, of *bos*; and *tit*, seven, of *tsoko*. These 17 words are additional to the 17 of the comparative vocabulary, and thus

furnish evidence of the common origin of the Niskwalli, of the south-west corner of British Columbia, and of the natives of Mysol, in the Malay Archipelago.

The Salish are regarded by Latham and other writers as an inland people, although some of them, such as the Niskwalli, dwell on the sea coast and on islands. They are, however, to a certain extent, cultivators of the ground, as are the inhabitants of the Malay Archipelago. The latter use the word *jagung* to denote maize, but the absence of that English term in all my vocabularies of the Salishan, save the Niskwalli, forbids the tracing of *jagung* to this continent. The Niskwalli word for maize is *stulels*, and this is undoubtedly the Sapparua *halal*, the Liang *allar*, the Wahai *allan*, the Cajeli *halai*, and the Batumerah *allai*, which mean rice. In Polynesia the term is applied to the chief article of vegetable food, the *Colocasia esculenta*, called *taro* in Maori, *talo* in Tonga, and *tela* in Rotuma. The Niskwalli *stulels* is an indication of a bread-making people, who are of necessity husbandmen. The principal Salishan deity seems to have been Dokwibutl. The first part of this word resembles *dugwe*, thou, and may thus represent invocation. Among the Dyaks of Borneo the chief god is Battara; the Tagalas worshipped Bathala Meycapal; and the people of Tobi called their divine progenitor, Pitakat. According to the Samoans, the first man was the product of the male principle Fatu and the female, Ele-ele, whence his name, Fatu-ele-ele. It is likely that these forms conceal the name of some eponym of the Malay-Polynesian people, or, at least, of a portion of them. In Sanchoniatho's Phœnician History, the second son of the ancestral Ouranus is called Betylus, and many things favour the derivation of the Malays from Canaanites of Semitic speech. Crawford says that Batara Guru, whom the people of Celebes call the first of their kings, is a local name of Siva. This statement is worthy of more than doubt.

Indian invasions of the Malay Archipelago, both Buddhist and Brahman, took place in or before the twelfth century, and, towards the close of the fifteenth, the Mahometans followed. These invasions caused great displacements of population for it is the warlike code of the Pacific Islanders to offer the conquered party the alternative of expatriation or extermination. Doubtless such alternatives were offered prior to the Asiatic invasions. It is clear, however, that the Salishans have not been displaced since they reached the American coast, while the Algonquins, of similar origin, have been driven into the far East, even to the shores of the Atlantic. The immigrants from Northern Asia reached British Columbia and Oregon as early as the beginning of the eighth century, and, finding the Algonquins there before them, drove them inland and eastward. The tide of northern Asiatics, called Toltecs and Aztecs, Otomis and Chichimecs, Sonora and Pueblo Indians, Muskhogean, Iroquois-Cherokees and Dakotans, continued to flow by Behring's Straits and the Aleutian chain for fully a century, so that the Salishans cannot have settled in America before the ninth century, and may not have settled before the fifteenth. No trace of either Sanscrit or Arabic appears in their language to shew that their period of emigration from the Malay Archipelago was posterior to the dominance of Hindoos and Mahometans. The divergence of their forms of speech from those of the present occupants of their ancient homes suggests a time when Malay forms were not so firmly rivetted in speech as has been the case since Europeans first knew the Pacific Islanders. It is likely that all our Indian tribes of oceanic derivation found their way to the shores of America before its coasts were known to Columbus and his followers. It is, of course, a guess in the form of a compromise, but it may be suggested, that the Salishans have been on this continent since the thirteenth century. The Maya-Quiches, of Yucatan and Guatemala, and the Algonquins must have preceded them some six hundred years.

The Rev. S. J. Whitmee, an authority on matters Polynesian, leaving the Malay Archipelago proper out of sight, has proposed a three-fold division of the insular

area. The people of negrito features and a postposing grammar in New Guinea, New Caledonia, the New Hebrides, Australia, etc., who have been termed Melanesian, he classifies as Papuan. The other islanders he divides into two groups. Those of Eastern Polynesia and New Zealand he calls the Sawaiori, a name compounded of the words *Sa-moa*, *Ha-wai-i*, and *Ma-ori*, denoting three representative peoples belonging to the race. To those of the north-western islands he gives the title Tarapon, from *Tara-wan* and *Pon-ape*, representative islands in the Gilbert and Caroline groups. A judgment based on partial vocabularies can hardly be a definite one; still a court must decide on the evidence before it, and render a verdict liable to revision should fuller testimony afterwards be forthcoming. At present the Malay element in the Niskwalli is represented by 51 Javanese, 45 Malay, 22 Sulu, 21 Sunda, 17 Bali and Mysol, 15 Tagala, 14 Bugis, 12 Bisayan, Madura, Wahai, and Tidore words. This decides nothing but the general fact of the Malay-Polynesian origin of the Salishans, save that in Tagala, Bugis, Macassar, Mysol, Menado, Salibabo, Saparua, Awaiya, Camarian, etc., the *tamata* or Polynesian form of the word for man appears, which is also Salishan. The Tarapon or Micronesian division of the South Sea Islands has but a small representation of some thirty words. But the Sawaiori division counts 51 Maori, 30 Tonga, and other verbal equivalents, showing that the Salishan stock is Sawaiorian. It has also verbal affinities to the languages of the Pelew islanders and the Malayan aborigines of Formosa, which suggest the route by which the Niskwalli and their brethren passed from the Malay Archipelago to the Hawaiian Islands and thence to the American coast.

The Malays have been called the Phœnicians of the East, and I have already hinted that Phœnician blood is in them. The enterprise that carried them to Madagascar in the west, and to Easter Island in the east, which sent them to the fishing grounds of Australia and to the ports of China, which pirate-wise swept the seas with hundreds of large war prahus and well-provisioned craft of many sails; that enterprise which brought to Central America the culture of the Maya-Quiches, and overflowed into the West India Islands long before Columbus reached their shores, became paralyzed when European voyagers, headed by the Portuguese, invaded their domain. Before they came, Hindoos, Arabians and Mongols had effected large displacements of population, but till late in the Sixteenth Century, fleets of three hundred sail, carrying fifty thousand combatants, were not unknown in their eastern seas. Of the Malay-Polynesian tribes, however, there is no such thing as continuous history. Their traditions blend with their mythology, and it is little to be wondered at that they and their widely-separated relatives should have preserved no record of their migrations, when the same is true of some of the most highly civilized nations.

Like the Malay-Polynesians, the Salishans are not scalpers, but decapitators or head-hunters, as were the extinct Beothiks of Newfoundland. Their canoes, also, are dug-outs, as originally were those of all tribes of insular origin. They tattoo the jaw and wear scanty clothing. When first met with they were not hunters and looked upon venison with disgust. Their fish-hooks, made of wood or bone, were similar to those of the South Sea Islanders. In regard to their mortuary customs, Dr. Franz Boas says: "The face of the deceased is painted with red and black paint. * *

* A chief's body is put in a carved box, and the front posts supporting his coffin are carved. His mask is placed between these posts. The graves of great warriors are marked by a statue representing a warrior with a war club. * * * After the death of husband or wife, the survivor must paint his legs and his blanket red. At the end of the mourning period, the red blanket is given to an old man, who deposits it in the woods." The Salishan lament of a mother over her dead child is, "*Ah seahb! shedda buddah ah ta bud! ad-de-dah!*" or, "Ah chief, my child is dead! Alas!"

So, one of the verses of a Tonga mourning is, "*O iaooe! gooa mate e!*" or, "Alas! he is dead!" The funeral customs of the Maoris of New Zealand, so far at least as chiefs are concerned, are, as described by Von Hochstetter, similar to those of the Salishans, even to the erection of a wooden image of the deceased over the grave and clothing it with his favorite articles of dress.

There are 18,000 Salishans in Canada and the United States, the result, it may be, of six centuries' development. Supposing their population to have gone on doubling within the reasonable rate of a century, or three generations, they must have landed on the Pacific Coast a little over 280 strong. Now, it is related that a Tonga chief set sail for the Fiji Islands, with two hundred and fifty followers in three large canoes, carrying also provision for the voyage. Four such canoes would have been ample accommodation for the Salishan immigrants, from whatsoever point they directed their course to the American shore. Their numbers can hardly have been less, in order to protect themselves from destruction by hostile tribes or incorporation in a stronger nationality. They do not seem to have come into contact with tribes of Northern Asiatic derivation to any extent, for their peculiar arts such as the birch canoe and the fabrication of pottery, were unknown to them. There is, therefore, nothing to traverse the testimony of language, which brings the Salishans from an ancient seat in the northern part of the Malay Archipelago.

COMPARISON OF NISKWALLI WITH MALAY-POLYNESIAN.

English.	Niskwalli.	Malay-Polynesian.
adze	kwalius	<i>galeleh Salibabo (axe)</i>
all	bokwi, bekw	<i>kabeh Java, Madura; fooabe Tonga.</i>
ant	mitchilola	<i>misisin Massaratty, mosisin Cajeli, pokoma Maori, mokohoola Tonga.</i>
arm	chalesh	<i>kaligh Formosa.</i>
arrow	shauks	<i>tkugh Formosa.</i>
	nokwed	<i>anakpanah Malay, gnahow Tonga, ngasau Fiji.</i>
ashes	skwallup	<i>gelap Mysol, orapu Bouton, labbu Sunda.</i>
axe	kobatit	<i>kapak Malay, Sulu; badog Sunda, badi Baju, beda Ahtiago.</i>
bad	kullub	<i>hala Java.</i>
belly	kwiuyukh	<i>awak Bali, Sunda (body), hatuaka Liang.</i>
	smukha	<i>cheong Samang, nanaka Liang (body).</i>
	klatch	<i>troke Malagasy, raga Bali (body), kaleh Salayer, kalakalath Pelew (body).</i>
bird	stlekelkub	<i>akepe, tekayap Mysol (fowl), topatopa Maori.</i>
(water)	skwakwelush	<i>walilis Sunda (teal).</i>
black	hitotsa	<i>hitam Malay, hidung Sunda, kokotu Tidore, kitkudu Gani, kokotu Sahoe.</i>
blanket	salitza	<i>klosso Java, kalasa Gani (mat).</i>
blue	hitotsa	<i>kotteetow Pelew.</i>
blood	toligwut	<i>darah Malay, gute Java.</i>
boat	kelobit	<i>yalopei Teluti, lopi Salayer, Bugis.</i>
	klai	<i>saloi Borneo, hol Teor.</i>
body	dautsi	<i>dada Morella.</i>
bone	sblanyu	<i>balung Java.</i>
bow	tsatsuts	<i>tito Atui.</i>
boy	chachas (little)	<i>cheka Sahoe, ichi ichi Ternate (little).</i>
bread, food	satld	<i>tela Rotuma.</i>
to break	ohwutl	<i>patah Malay, whawhati, ngawhere Maori.</i>
breast	skubo	<i>uma Maori.</i>

English.	Nisikwalli.	Malay-Polynesian.
to burn	ohod	joting, <i>Bali</i> , tahu <i>Maori</i> , katia <i>Fiji</i> .
child	miman	ninana <i>Sulu</i> .
	bibad	bibigi <i>Tonga</i> .
cloud	skwushub	hapas <i>Rotti</i> , hambubu <i>Bali</i> , kapua <i>Maori</i> , yabbath <i>Pelew</i> .
cold	tus	tiis <i>Sunda</i> , toe <i>Atui</i> , tijok <i>Malay</i> .
to come	atla, utla	haere <i>Maori</i> , iraua <i>Formosa</i> , alowei <i>Awaiya</i> , dirawoei <i>Java</i> .
crab	beskwu, beskhu.	papaka <i>Maori</i> , bokoti <i>Wahai</i> (prawn).
	hawetsa	kapiteng <i>Java</i> , <i>Bali</i> .
	hauwilo	ulai <i>Cajeli</i> (prawn).
day	slahel	allo <i>Salayer</i> , alli <i>Moluccas</i> , lilew <i>Teor</i> , kluh <i>Mysol</i> , kila <i>Teluti</i> , kaseiella <i>Wahai</i> , malal <i>Gah</i> , liar <i>Massaratty</i> , ari <i>Malay</i> .
dog	kobai	kapuna <i>Menado</i> , kafuni <i>Gah</i> .
	komai	kamia <i>Rotuma</i> , segawon <i>Java</i> .
door	shugwtl	batal <i>Mysol</i> , yebuteh <i>Gah</i> .
ear	kwillade	herenatia <i>Amblaw</i> , karin <i>Teor</i> .
earth	swatekhwtlen	cootoom <i>Pelew</i> , thanthan <i>Rotuma</i> .
to eat	oatld	tauri <i>Fiji</i> .
egg	oos	gosi <i>Tidore</i> , hua <i>Maori</i> .
end	eluks	alos <i>Malay</i> , hiliang <i>Tonga</i> .
eye	kalus	karu <i>Maori</i> , lau <i>Tidore</i> , lako <i>Galela</i> .
face	satzus	sotyo, socho <i>Java</i> (eye), gati <i>Sanguir</i> .
father	man	amana <i>Bouton</i> , mam <i>Mysol</i> .
	bad	pito <i>Java</i> , medua <i>Tahiti</i> .
fear	ashuts	takut, coquet <i>Malay</i> .
	ashekwub	magtahap <i>Bisayan</i> , hopohopo <i>Muori</i> .
feather	stokw	hokai <i>Maori</i> , dokoi <i>Sanguir</i> , gogo <i>Tidore</i> .
field	makwob	twawfa <i>Tonga</i> , kabun <i>Sulu</i> , sabah <i>Lampung</i> , sawah <i>Java</i> .
finger	shalatchi	jariji <i>Bali</i> , garikih <i>Madura</i> , saranga <i>Bouton</i> , koroiti <i>Maori</i> .
fire	hod, hot	hatete <i>Maori</i> , kidjaik <i>Mille</i> .
		nggatu <i>Fiji</i> , putun <i>Sanguir</i> .
flesh	beyets	paa <i>Tagala</i> , mbithi <i>Fiji</i> , wat <i>Formosa</i> , waouti <i>Awaiya</i> .
flower	sekaisim	puspo-kusumo <i>Java</i> , kaotutun <i>Massaratty</i> , sekar <i>Java</i> .
fly	hwaio	tawon <i>Java</i> (bee), tuiaui <i>Maori</i> (flea), owei <i>Mysol</i> (mosquito), guphu <i>Tidore</i> .
foot	shid	siki <i>Sulu</i> , kadan <i>Wahai</i> , hoots <i>Malagasy</i> , wed <i>Gani</i> , oweda <i>Matabello</i> .
forehead	silels	alis <i>Malay</i> , lae <i>Tonga</i> , Fakaaso.
girl	chachas slane	lehani <i>Rotuma</i> (daughter).
to give	abshits	haweh <i>Java</i> , wacito <i>Tobi</i> , evaha <i>Tahiti</i> , anna-bookeeth <i>Pelew</i> .
to go	ookh	iigkau <i>Sulu</i> , jog <i>Mysol</i> , iko <i>Wahai</i> , ako <i>Ahtiago</i> , wiko <i>Massaratty</i> .
	ohob	bo <i>Mysol</i> , aou <i>Wahai</i> , taboi <i>Borneo</i> , ngawa <i>Maori</i> .
good	klob, tlob	malopi <i>Saparua</i> , rap <i>Tarawan</i> , taloha <i>Galela</i> , rawe <i>Maori</i> .

English.	Niskwalli.	Malay-Polynesian.
grasshopper	kekowuts	kakopi <i>Liang</i> , kohati <i>Wahai</i> (butterfly),
grease	swus	gososo <i>Galela</i> .
great	hekwa	agang <i>Malay</i> , daco <i>Bisayan</i> , koiwi <i>Maori</i> , jackabey <i>Malagasy</i> , bagewa <i>Salibabo</i> .
hair	skadzo	hutu <i>Tidore, Galela</i> .
beard	kwed	couder <i>Malay</i> .
hand	chalesh	chiulok <i>Lampung</i> , ala <i>Awaiya</i> , harau <i>Java</i> , ngalan <i>Tagala</i> , arsiu <i>Rotuma</i> .
hard	swagwil	hagal <i>Madura</i> , mukola <i>Wahai</i> .
	klukhu	karas <i>Lampung</i> , kereh <i>Kiisa</i> , kras <i>Malay</i> , las- elasea <i>Fiji</i> .
head	shaiyus	chetuk <i>Madura</i> , jahe <i>Mangarei</i> , kahutu <i>Mysol</i> , oyuko <i>Teluti</i> .
heaven	shukh	hakoso <i>Java</i> , shurga <i>Sulu</i> .
hot	skwul, otsgulla	wera <i>Maori</i> , vela <i>Tonga</i> , pelah <i>Mysol</i> , asala <i>Alfuros</i> .
	nuskwullum	mogall <i>Pelew</i> .
house	alal	balay <i>Bisayan</i> , fale <i>Fakaafu</i> , falle <i>Tonga</i> , are <i>Raratonga</i> .
husband	chesthu	as-auah <i>Tagala</i> , essah <i>Salibabo</i> , heieiti <i>Wahai</i> (man), tahu <i>Maori</i> .
insect	slitlalkub	lalangow <i>Borneo</i> , ralugoh <i>Menado</i> (fly).
iron	snokw	saloko <i>Java</i> (silver).
kettle	sialt	kwali <i>Malay</i> , quall <i>Pelew</i> , gooloo <i>Tonga</i> .
knee	lakalotsid	lukut, lutut <i>Malay</i> .
leaf	chuboba	chafen <i>Teor</i> , lai obawai <i>Amblaw</i> .
life	hale, halikh	ara <i>Tahiti</i> , ora <i>Maori</i> .
louse	beskchad	okutu <i>Bouton</i> .
maize	stulels	halal <i>Saparua</i> , allar <i>Liang</i> (rice).
man	stobsh, stobush	taowe <i>Bugis</i> , tumata <i>Saparua</i> , tomata <i>Salibabo</i> , taumata <i>Menado</i> , tamata <i>Fiji</i> .
chief	siab	sau <i>Rotuma, Fiji</i> , how <i>Tonga</i> .
people	atsiltelmu	tiyang-jalmi, jalmo <i>Java</i> , jalama <i>Sunda</i> .
mat	kot	katini <i>Massaratty</i> , junguto <i>Galela</i> .
	skwegwut	savata <i>Sulu</i> , moamata <i>Tarawan</i> , takapan <i>Maori</i> , <i>Tonga</i> .
moon	slokwalm	wulan <i>Java</i> , hulani <i>Batumerah</i> , hulan <i>Wahai</i> , allong <i>Mille</i> .
mosquito	kwad	seugeti <i>Massaratty</i> , suti <i>Cajeli</i> , kias <i>Borneo</i> .
mother	sloi	koka <i>Maori</i> , ngei <i>Fiji</i> , yaiya <i>Tidore</i> .
mountain	skwatutsh	vohitcht <i>Malagasy</i> .
	spokwab	chubuk <i>Samang</i> , buguid <i>Bisayan</i> , waukein, <i>Formosa</i> , eothiva, <i>Fiji</i> .
mouth	kadhu	igad <i>Sulu</i> (lips), gnootoo <i>Tonga</i> , nhoutou <i>Ticopia</i> , ngutu <i>Fakaafu</i> , ngutu <i>Maori</i> (lips).
nails	kohwachi	kuku <i>Malay</i> , kuyat <i>Gani</i> , wuku <i>Gah</i> , oggok <i>Mille</i> .
name	sda, sdas	wasta, <i>Java</i> , yatha <i>Fiji</i> .
neck	kaiukhkwa	kaki <i>Maori</i> , kia <i>Rotuma</i> , gia <i>Tonga</i> .
night	klakh, sklakh	galap <i>Malay</i> (dark), marok <i>Mille</i> (dark).
	slakhhel, sklakhel	garagaran <i>Gah</i> , kloowaizeris <i>Tobi</i> (dark).
no	hwe	hea <i>Tonga</i> , akea <i>Tarawan</i> .
nose	muksn, mukshid	muk <i>Samang</i> , hungasan <i>Bali</i> .

English.	Niskwalli.	Malay-Polynesian.
old	lolutl tusak	kolot <i>Sunda</i> , lakalaki <i>Cagayan</i> . tuhak <i>Samang</i> , tuah <i>Malay</i> , tawhito <i>Maori</i> , tuha <i>Lampung</i> .
prawn	boluto saikh	burowi <i>Tidore</i> , filuan <i>Ahtiago</i> . kasaua <i>Mysol</i> .
rain	skal	kull <i>Pelew</i> , ulah <i>Amblaw</i> , hura <i>Galela</i> , karu <i>Tarawan</i> , golim <i>Mysol</i> .
rainbow	kobatshid, komachin	kuwung <i>Java</i> , <i>Bali</i> .
rat	skad pelkutchi	tikus <i>Malay</i> , tikuti <i>Massaratty</i> . warset <i>Java</i> , barut <i>Sunda</i> , balawu <i>Bugis</i> , blaha <i>Salayer</i> .
red	hekwetl	kula <i>Fakaafu</i> , <i>Fiji</i> , desoella <i>Galela</i> , kohori <i>Tidore</i> , coola-coola <i>Tonga</i> , whero, towhero <i>Maori</i> , habrit <i>Java</i> .
river	stolukw	laialak <i>Rotti</i> , walungan <i>Sunda</i> , ylog <i>Tagala</i> , lungei <i>Borneo</i> .
root	aspuđ	gamut <i>Sulu</i> , aiwaht <i>Ahtiago</i> , eiwaati, <i>Morella</i> , aiwaat <i>Lariki</i> , owati <i>Amblaw</i> , hatimootoo <i>Tidore</i> .
saliva	kwulotsid	ludah <i>Malay</i> , tohulah <i>Saparua</i> , tehula <i>Liang</i> , haware <i>Maori</i> .
salt	kakam	garam <i>Malay</i> , asin <i>Bisayan</i> , teisim <i>Alfuros</i> , asing <i>Menado</i> , masima <i>Tonga</i> , <i>Fiji</i> .
sea	hwultsh	wolat <i>Gani</i> , belot <i>Mysol</i> , olat <i>Cajeli</i> , alud <i>Borneo</i> , lajit <i>Mille</i> .
to see	olabit	liat <i>Malay</i> , lewa, lelewa <i>Fiji</i> .
to sit	gwuddel	kuduk <i>Borneo</i> , tuturu <i>Maori</i> .
slave	stoduk	ata <i>Bugis</i> , budak <i>Malay</i> , taurereka <i>Maori</i> .
snake	betsuts	taksoko <i>Java</i> , ngata <i>Fiji</i> , tekoss <i>Gah</i> , katoun <i>Menado</i> .
	wekhpash	ekeb <i>Samang</i> , savha <i>Bouton</i> , pok <i>Mysol</i> , dipa <i>Borneo</i> , tofagin <i>Matabello</i> .
snow	bako	huka <i>Maori</i> .
skin	hudzamid	usam <i>Wayapo</i> , usum <i>Cajeli</i> , asava <i>Batumerah</i> , mot-kehin <i>Mysol</i> .
small	miman	moemoe <i>Tonga</i> , meamea <i>Rotuma</i> , nobinohi <i>Maori</i> , anaanin <i>Alfuros</i> .
	mimad	munti <i>Tagala</i> , umit <i>Borneo</i> , mohintek <i>Belang</i> .
	chachas	cheka <i>Sahoe</i> , ichi-ichi <i>Ternate</i> , chiyut <i>Java</i> .
soft	esmetlin, asbetlil	lam-but <i>Malay</i> , lem-but <i>Madura</i> , malumu <i>Wahai</i> , mamalin <i>Ahtiago</i> .
sour	ochapab	dakiopi <i>Galela</i> , mateibi <i>Gah</i> , pep <i>Mysol</i> , asam <i>Java</i> , kawa <i>Maori</i> .
to speak	ohothot	kata <i>Malay</i> , taitai <i>Tarawan</i> , whakatu <i>Maori</i> .
spear	tseakwuts	wahos <i>Java</i> , tawaki <i>Amblaw</i> , sagusagu <i>Tidore</i> , hoata <i>Maori</i> , tcao <i>Rotuma</i> , kwukeou <i>Fiji</i> , bakabota <i>Tarawan</i> , taofotoi <i>Tonga</i> .
	tatl	tara <i>Tarawan</i> , golo <i>Java</i> , tite <i>Wahai</i> , galagala <i>Teor</i> .
	stetkwub	tuba <i>Ahtiago</i> , tabi <i>Tarawan</i> .
squirrel	skadzu	katek <i>Java</i> (monkey), keso <i>Amblaw</i> , kesoi <i>Cajeli</i> , kesi <i>Awaiya</i> , kuyad <i>Borneo</i> (monkey).

English.	Niskwalli.	Malay-Polynesian.
star	chusud	chetu <i>Atui</i> , <i>tahwettu Tahiti</i> , <i>tuitui Tarawan</i> , tokun <i>Teor</i> , hetu <i>Paumotua</i> .
stone	chetla	selo <i>Java</i> , batro <i>Biajuk</i> , batu <i>Malay</i> , wahto <i>Formosa</i> , hathu <i>Rotuma</i> , kowata <i>Maori</i> .
sun	klokwatl	matalo <i>Macassar</i> , lacloh <i>Rotli</i> , adlao <i>Bisayan</i> , matalou <i>Borneo</i> , kaliha <i>Sanguir</i> , kluh <i>Mysol</i> , woleh <i>Gah</i> , yaro <i>Tobi</i> , komaru <i>Maori</i> .
sweet	okwagwab	masoma <i>Camarian</i> , masuma <i>Lariki</i> , mosuma <i>Saparua</i> .
teeth	dzadis	gigi <i>Malay</i> , isi <i>Sanguir</i> , <i>Bugis</i> , ngisi, <i>Menado</i> , ngedi <i>Sahoe</i> , ngutu <i>Savu</i> , donglto <i>Bolanghitam</i> , danto <i>Java</i> .
tongue	klalap	lila <i>Bugis</i> , <i>Macassar</i> , hilat <i>Bali</i> , lilah <i>Sulu</i> , kelo <i>Garam</i> , alelo <i>Sandwich</i> , lella <i>Malagasy</i> , elelo <i>Tonga</i> , alele <i>Rotuma</i> .
tree	tsukhwul	tangkhal <i>Sunda</i> , garager <i>Pelew</i> , kalu <i>Sanguir</i> (wood), ngahere <i>Maori</i> (wood).
	stukhum	pohon <i>Madura</i> , ayun <i>Timuri</i> , chuk <i>Samang</i> , cago <i>Iloco</i> , tawhao <i>Maori</i> (wood).
water	ko	chai <i>Sunda</i> , hoi <i>Timor</i> , aki <i>Ratahan</i> , akei <i>Menado</i> , aki <i>Sanguir</i> , <i>Tidore</i> , komo <i>Paumotua</i> .
white	hokokh	puteh <i>Malay</i> , maydac <i>Batan</i> , babut <i>Ahtiago</i> , botcibotc <i>Tobi</i> , savasavu <i>Fiji</i> , kowse <i>Pelew</i> .
wind	shukhhum	angin <i>Malay</i> , kanging <i>Bali</i> , kalm <i>Bali</i> , hangin <i>Tagala</i> , matangi <i>Marquesas</i> , kohengi <i>Maori</i> , koyyoou <i>Pelew</i> .
wing	tsetsal	teyholi <i>Awaiya</i> , keheil <i>Wahai</i> , tula <i>Sanguir</i> , wakul <i>Gah</i> ,
wife	chugwush	sawah <i>Sulu</i> , sawa <i>Sanguir</i> , sauwa <i>Borneo</i> , sowom <i>Cajeli</i> , sengwedo <i>Java</i> , ahehwa <i>Matabello</i> .
woman	slade, sklane	lanjang <i>Sunda</i> (girl), lehani <i>Rotuma</i> (daughter), rin <i>Mille</i> (wife), leva <i>Fiji</i> , erire <i>Paumotua</i> , elwinyo <i>Amblaw</i> , lako <i>Baju</i> (wife), gallu <i>Java</i> , loh <i>Bali</i> , lubawe <i>Biajuk</i> .
yellow	hokwats	bahendak <i>Biajuk</i> , koothoo <i>Pelew</i> .
young	babaad	muda <i>Malay</i> , punua <i>Maori</i> .
I	atsa, kets, chid	aku, saya, <i>Malay</i> , kito <i>Java</i> , gita <i>Tonga</i> , atu <i>Tahiti</i> , tia <i>Tarawan</i> , zaho <i>Malagasy</i> .
Thou	dugwe, kats, chu	diko <i>Java</i> , dika <i>Madura</i> , kowe <i>Java</i> , <i>Ponape</i> , kow <i>Pelew</i> , kwe <i>Mille</i> , coy <i>Tonga</i> , koe <i>Maori</i> , sia <i>Sunda</i> , iko <i>Bugis</i> , go <i>Tarawan</i> .
He	tzil, tzinil	ini <i>Malay</i> , anre <i>Macassar</i> , kania <i>Sulu</i> , tena <i>Tarawan</i> , diri, sandiri <i>Malay</i> .
	shi, sha	dia <i>Malay</i> , iya <i>Lampung</i> , siya <i>Sulu</i> , yca <i>Tagala</i> , izi <i>Malagasy</i> .
We	debetl	giwotoloo, <i>Tonga</i> , kendaru <i>Fiji</i> .
	sutshid	kita <i>Malay</i> , <i>Sulu</i> , <i>Ponape</i> , tatou <i>Tahiti</i> , <i>Paumo-</i> <i>tua, Maori</i> .
	shil, chitl	kula <i>Java</i> , sira <i>Batan</i> , tautolu <i>Tonga</i> , derro <i>Mille</i> , ara, ngaira <i>Tarawan</i> .
You	gullapo	kowe <i>Java</i> , korua <i>Maori</i> , <i>Paumotua</i> .
They	detl, tsataditl	nautolu <i>Tonga</i> .

English.	Niskwalli.	Malay-Polynesian.
	ulgwa, delgwa	eris <i>Rotuma</i> , la, latou <i>Samoa</i> , raua, ratau <i>Tahiti</i> , <i>Paumotu</i> , <i>Maori</i> .
1	dutcho, asdutcho	tadday <i>Cagayan</i> , tatsaat <i>Formosa</i> , tasi <i>Fotuna</i> , <i>Fakaafu</i> , tahi <i>Maori</i> , <i>Uea</i> , <i>Marquesas</i> , taha <i>Tonga</i> , tot <i>Caroline</i> , tseekae <i>Malicollo</i> .
2	assale, salew	kaleh <i>Java</i> , serou <i>Papua</i> , dalaua <i>Tagala</i> , kalae <i>Tambora</i> , rua <i>Lampung</i> , golu <i>Tobi</i> , heluk <i>Yengen</i> , oroo <i>Pelew</i> , erooa <i>Otaheiti</i> .
3	klekhw, asklekhw	telu <i>Java</i> , kolu <i>Sandwich</i> , atlo <i>Philippine</i> , tatlu <i>Tagala</i> , gatil <i>Sulu</i> , kal <i>Kissa</i> .
4	bos, asbos	pat, papat <i>Java</i> , opat <i>Sunda</i> , epat <i>Biajuk</i> , effats <i>Malagasy</i> , upat <i>Sulu</i> , <i>Bisayan</i> , opats <i>Bugis</i> , pobits <i>Yengen</i> , ebats <i>Malicollo</i> .
5	tsalats	luwi <i>Malagasy</i> , kuklin <i>Tambora</i> , lailem <i>Mille</i> , delima <i>Salibabo</i> .
6	dzelachi	loacha <i>Uea</i> , chalemen <i>Lifu</i> , dildjino <i>Mille</i> laen <i>Rotti</i> , <i>Timuri</i> , hol <i>Caroline</i> , gurum <i>Tuham</i> .
7	tsoks	tujuh <i>Malay</i> , tuju <i>Sunda</i> , tik <i>Papua</i> , tuju <i>Sambawa</i> , tujuh <i>Samang</i> , tujoh <i>Salayer</i> , hiku <i>Sandwich</i> , iko <i>Kissa</i> .
8	tkachi	hasto <i>Java</i> , kutus <i>Bali</i> , tofkangi <i>Ternate</i> , koneho <i>Tambora</i> , gatahua <i>Sulu</i> , tufkangi <i>Tidore</i> , itupangi <i>Galela</i> .
9	hwul	jalatien <i>Biajuk</i> , asera <i>Bugis</i> , lali <i>Tambora</i> , siwer <i>Teor</i> , sior <i>Malagasy</i> .
10	paduts	sadasu <i>Java</i> , dasa <i>Bali</i> , painduk <i>Yengen</i> , putusa <i>Serang</i> , manud <i>Tuham</i> , mackoth <i>Pelew</i> , boto <i>Cajeli</i> , hutusa <i>Awaiya</i> , hutu <i>Teluti</i> , fotusa <i>Alfuros</i> , huta <i>Teor</i> .
20	salachi	kalehdoso <i>Java</i> , calohaen <i>Bisayan</i> , oloyuck <i>Pelew</i> , ruatekau <i>Maori</i> , sisarone <i>Tambora</i> .
100	sumkwachi	sangagasut <i>Iloco</i> , hangutoos <i>Sulu</i> , sangdaen <i>Tagala</i> , usakagatos <i>Bisayan</i> , magatu <i>Cagayan</i> , mahasu <i>Menado</i> , <i>Sanguir</i> .
this, that	ti	itu <i>Malay</i> , eta <i>Sunda</i> , heto <i>Biajuk</i> , tudeh <i>Samang</i> , taua <i>Maori</i> .
	ki, kwi	iki, ika, <i>Java</i> , iyak <i>Sunda</i> , iya <i>Batan</i> .
	la, le, til	reyah, rowa, girowa <i>Madura</i> , yari <i>Tagala</i> , raua, tera <i>Maori</i> .
who ?	gwat	sinten <i>Java</i> , yewe <i>Biajuk</i> , isiu <i>Sulu</i> , siapa <i>Malay</i> , kohai <i>Tonga</i> .
here	hwulte	hiriki, diriki <i>Bali</i> , korini <i>Bugis</i> .
there	todi, altodi	ditu <i>Bali</i> , disitu <i>Malay</i> , ditu <i>Sunda</i> , disah, kahdisah <i>Madura</i> , didto <i>Bisayan</i> , didtoo <i>Sulu</i> , dita <i>Iloco</i> , etonai <i>Tobi</i> .
near	chicht	jaub, dakat <i>Malay</i> , chadak, <i>Java</i> , asideg <i>Iloco</i> , tutatu <i>Maori</i> .
far	lel, lalél	bela <i>Macassar</i> , mabela, <i>Bugis</i> , halayo <i>Bisayan</i> , arayu <i>Cagayan</i> , malayo <i>Tagala</i> .
above	shishukh, shikabuts	asa <i>Bugis</i> , atas, <i>Malay</i> , kepeng <i>Samang</i> , ybabao <i>Tagala</i> , saitaas <i>Bisayan</i> , hataas <i>Sulu</i> , hage <i>Tonga</i> .

English.	Niskwalli.	Malay-Polynesian.
behind	lak, tulak	licuc <i>Cagayan</i> , licudan <i>Iloco</i> , licurran <i>Tagala</i> , blakang <i>Malay</i> , iligan <i>Mille</i> , tukalek <i>Tobi</i> , tuara <i>Maori</i> .
below	klep	ngandap <i>Java</i> , dibawah <i>Malay</i> , andap <i>Sunda</i> , rawa <i>Macassar</i> , oleekem <i>Pelew</i> , gilalo <i>Tonga</i> , lausilopo <i>Rotuma</i> , kabawah, <i>Sulu</i> , sulib <i>Tagala</i> .
by	twul	ulih <i>Malay</i> , ri <i>Bugis</i> .
from	tul	dari <i>Malay</i> , <i>Madura</i> , huleh <i>Bali</i> .
in	dekhw	di <i>Malay</i> , <i>Sunda</i> , <i>Lampung</i> .
to	ta, tud tul, gwul	dateng <i>Java</i> , tako <i>Java</i> , di <i>Batan</i> , atoo <i>Tonga</i> . wor <i>Tobi</i> .
with	twul	karo, kalih <i>Java</i> , kalawan <i>Lampung</i> , barang <i>Bali</i> , <i>Madura</i> .
within	dekhw	dalam <i>Malay</i> , <i>Madura</i> .
without	shalbekhw	salebetting <i>Java</i> (within), saliwang <i>Bugis</i> .

MOSS LITTER. BY THOMAS W. GIBSON, ESQ., BUREAU OF MINES.

(Read January 30th, 1897.)

Agriculture and mining are the chief members of a group of arts which lie at the base of all others—without which, indeed, none others could exist. Agriculture supplies the primal necessities of man by giving him food and clothing, and both together furnish him with the raw materials for that wonderful and complex series of manufactures, with which his ingenuity strives to gratify his tastes or satisfy his wants—tastes and wants which enlarge with his expanding civilization. They have both the same arena—the capacious bosom of Mother Earth—and both strive to turn to advantage the substances which nature there has placed. One enlists in her service those vital forces which draw the atoms of inorganic matter from air and soil, and which raise them from the mineral into the vegetable, and from the vegetable into the animal kingdom; the other deals directly with the mineral substances themselves, and by the mere act of changing their situation and separating them from one another, rescues them from inutility and makes them subservient to the wants of man. One may be called an adaptive industry, whose processes, if rightly conducted, move in a circle, and appear capable of being carried on for all time; the other may be termed a destructive industry, concerned with large, yet strictly limited quantities of material, which, once brought into play, are forthwith made subject to decay and waste, and are scarcely, if at all, capable of being restored to their original condition. Agriculture and mining touch each other at many points. The farmer feeds and clothes the miner; the miner warms the farmer, supplies him with fertilizers, keeps him in ploughs and harrows, and puts gold and silver into his purse. No market is worth so much to the tiller of the soil as a mining camp in full blast. Miners usually want the best, and are quite willing to pay for it.

There are processes performed on the surface of the ground which, in their nature, seem intermediate between agriculture and mining, and to partake of the character of both. One of these is the reclamation of peat bogs, and the utilization of the material of which such bogs are composed. As agricultural operations, such processes restore to cultivation considerable areas of land, previously lying waste and barren, while, viewed as incidents of mining, they convert to man's use actual portions of the earth's crust unchanged except by a certain amount of manipulation.

The origin of peat bogs is well understood. They are found chiefly in the colder parts of the globe, where evaporation goes on less actively than in the more tropical regions, and occur in low situations, or where some natural or artificial obstacle impedes the drainage. The abundant moisture favors the growth of a low order of plants, such as the sphagnum mosses, of which some fifty or sixty varieties are known. This plant is distinguished above all others by its capacity for absorbing and storing water, for which its peculiar structure eminently fits it. The epidermis of the stalk and the leaves of the plant are mainly composed of large, empty cells, into which the water is drawn through a number of small holes. The cells are provided with ring or spiral-formed thickenings on their inner sides, which keep them from collapsing. They are consequently always distended, and always ready for use. Smaller cells occur between the larger ones, which contain chlorophyll and supply the plant with nourishment, but these occupy comparatively little space. The whole arrangement is that of an aggregation of reservoirs in successive layers, which are kept filled by the force of capillary attraction, even when the plant itself is above the water level.

It is curious to note that the properties of the sphagnum moss, which render it so well adapted for living in a low and moist situation, tend also to bring its existence to an end. It requires a constant supply of moisture, yet it is continually

pumping up to the surface of its tufts the water in which it stands, thus promoting evaporation ; while at the same time, by regularly decaying at its roots, it deposits the detritus which adds to the solid contents of the bog. This process continues until the bog is raised above the level of the surface water, when the sphagnum vegetation ceases, having exhausted the conditions which made it possible. In this way bogs of considerable depth are formed in process of time. As the mass increases, decomposition takes place in the lower portions, which become consolidated into a black or dark-brown earthy substance, that in various parts of the world is extensively converted into fuel. The usual method of utilizing it as such is to dig up the peat in cakes, or blocks, and dry them by exposure to the wind and sun, after which they are stored and used as required. Hand labor is generally employed, though numberless attempts have been made to facilitate the process by the introduction of various kinds of machinery. The great difficulty in the economic employment of mechanical processes is the tenacity with which the peat retains the degree of moisture remaining after it has yielded all that naturally evaporates in the air. Pressure and artificial heat have been resorted to in order to overcome this difficulty, but, while the end aimed at is capable of achievement, it has usually been attained at too great an expense for economic results. A process which would put us in possession of a good and cheap peat fuel would be a national benefit to Ontario, destitute as the Province is of workable beds of coal.

It is these absorptive properties of the sphagnum moss which have led to its employment as litter, or bedding for cattle, in lieu of straw or other materials commonly used for such purposes. Its suitability for litter was doubtless recognized at an early date by people living in the vicinity of bogs, but it was as late as 1880 that the preparation of moss litter as an article of commerce was first begun by Hollman at Gifhorn, in Hanover. Since that time it has come rapidly into use in the countries of Continental Europe, and in Great Britain, as well as to some extent in America. The advantages claimed for the litter are that it affords drier and healthier bedding for horses and cattle than any other material ; that by reason of its great power of absorbing moisture, it binds the valuable portion of the animal excrements, and consequently yields the best manure ; that it acts as a disinfectant and improves the air of the stable, and that a smaller quantity of it is required than would be needed if straw were used. Experience with the litter in European countries seems to show that the claims made for it are well founded, and that it is the best article for the purpose yet introduced.

The cells of the sphagnum moss in the manufactured article retain much of their power of attracting and holding water, and the litter is in consequence able to take up ten or fifteen times its own weight of moisture. It has the faculty of absorbing gases as well, and hence fixes the ammonia always present to a greater or less degree in the atmosphere of buildings in which animals are confined and fed. The soft, springy, elastic moss litter forms a more comfortable bed for cattle than straw, and greatly facilitates the task of keeping the animals and stables clean, a fact which has an important bearing on the welfare of man, as in the case of milch cows whose product is used as an article of human diet.

Careful trials of moss litter in army stables in Germany, where formerly straw was employed, showed its superiority in the following respects : dry beds, and dry, fresh air, free from ammonia ; the ceilings, walls and leather trappings remained free from moisture and mould. If proper care was taken to remove those portions of the litter which became charged with moisture, to shake it up every day and fork it from one part of the stall to another, the horses found their quarters very much improved. Their skins remained clean and in activity, catarrhs of the nose and eyes, generally the result of bad air in stables, were less frequent ; wounds on the legs healed more speedily ; colic was almost eliminated ; inflammations of the glands seldom occurred, and rotting of the frog was almost entirely prevented. In cases of contagious disease, the litter proved of great value, and surpassed all other

disinfectants. In other cases, too, moss litter, mixed with superphosphate, has had the effect of protecting cattle from foot and mouth diseases, even while the infection spread to an alarming extent on neighboring farms. This property would doubtless make it valuable for use in railway cars employed in the transportation of live stock. Many cases have been known in which disease was introduced or spread by cars in which infected animals had been carried.

The manurial value of moss litter, after it has served its purpose in the stable, is greater than that of straw, for the reason that there is less evaporation of the liquid and volatile constituents. It would appear that no greater proportion of the potash, lime, or phosphoric acid is recoverable by means of the litter, but the easily-soluble nitrates are retained to a much larger extent than in the straw, which allows of their escape in the form of ammonia. As the agriculturist well knows, the nitrogen thus rendered available for plant food is a most valuable element of manure.

In the manufacture of moss litter, as carried on in Europe, a fine dust is sifted out at a certain stage of the process, which, as well as the litter itself, is used as a deodorizer and absorbent of sewage and fecal matter, especially in small cities, where no proper systems of sewerage or drainage exist. Accumulation of noxious matter of this sort often gives rise to epidemic and infectious diseases. The use of moss litter and peat dust not only remedies this evil, but actually transforms deleterious waste into valuable fertilizers. The absorbent properties of the litter check the growth of bacteria, and retard the decomposition of organic substances. Fresh fish, fruit, and vegetables are all said to have been preserved in excellent condition for a long time by being packed in peat moss. There are many other uses to which moss litter is put, such as raw material for coarse textile fabrics, a non-conductor of heat or noise in house building, paper pulp, etc., with greater or less success.

The peat bogs of Canada, and of Ontario in particular, are of vast extent. By virtue of their immense stores of carbon, they constitute a potential source of fuel supply when the right process of manufacture shall have been invented and applied. Meantime, a beginning has been made in the utilization of these bogs in the manufacture of moss litter. In the townships of Wainfleet and Humberstone, in the County of Welland, between the feeder of the Welland Canal and Lake Erie, and about five miles from the town of Welland, lies a peat bog of some 5,000 acres, owned by the Canadian Peat Fuel Company of Toronto. At the northern edge of this bog the company has erected a plant for the manufacture of the litter, according to a process which in some respects differs from that prevailing in Europe. The upper layer of the bog consists of undecomposed sphagnum moss, varying in depth from 18 inches to 4 1-2 feet, is said to be free from sand or inorganic material, and to be well fitted for litter. The works have been erected and put in operation, and a considerable quantity of product has been turned out. The first stage of the process is to cut the moss into pieces about eighteen inches square, which are piled together in rows on the surface of the bog. When the moisture has sufficiently evaporated these blocks are gathered and wheeled in small cars, over a portable tramway, to the storing sheds. They are then passed through the picking machines, two of which stand side by side. These are provided with heavy revolving cylinders, armed with strong teeth, which act upon similar teeth set in the concave surface of a breast, against which they work. In the pickers the moss is torn and loosened apart, the object being to separate the fibres, rather than break them. The pickers discharge the moss upon moving carriers, three in number, to each machine, ranged above one another, which carry it horizontally through a drying chamber, or tunnel, 116 feet in length, 8 feet high, and 16 feet wide. These carriers travel against a current of hot air, drawn through the tunnel by a disc fan revolving at the farther end, the object being to remove the greater part of the moisture remaining in the moss. The heat for this purpose is generated by a furnace, situated parallel to the tunnel, whence the hot air is drawn by the suction of the fan into a mixing chamber, where the temperature can be

regulated by the admission of cold air. The hot blast, after passing over the moss, emerges, laden with moisture, into a wooden shaft, and so into the outer air. At the end of the drying tunnel the moss falls into a conveyer, from which it is elevated into a weighing bin, or hopper, situated above a baling press, or packer. The hopper works automatically, and as soon as a sufficient weight is received it deposits its load in the press, which is a machine of peculiar design, worked by steam power. On a revolving circular platform are four stout wooden moulds. In one of these wooden slats are placed to assist in securing the bale after it is pressed; it passes under the press, the workman above moves a lever, and a plunger descends with a pressure of 200 tons, forcing the moss firmly into the mould. The platform makes a quarter revolution, and while the second mould is being filled, number one is being secured with wire, and at the third turn the finished bale is removed, ready for shipment. The weight of a bale is 250 to 260 pounds. A knuckle-joint press is subsidiary to the steam press, but is seldom required. The bales are stored in the sheds, whence they can be shipped as called for, over the Michigan Central Railroad, a spur of which runs into the property.

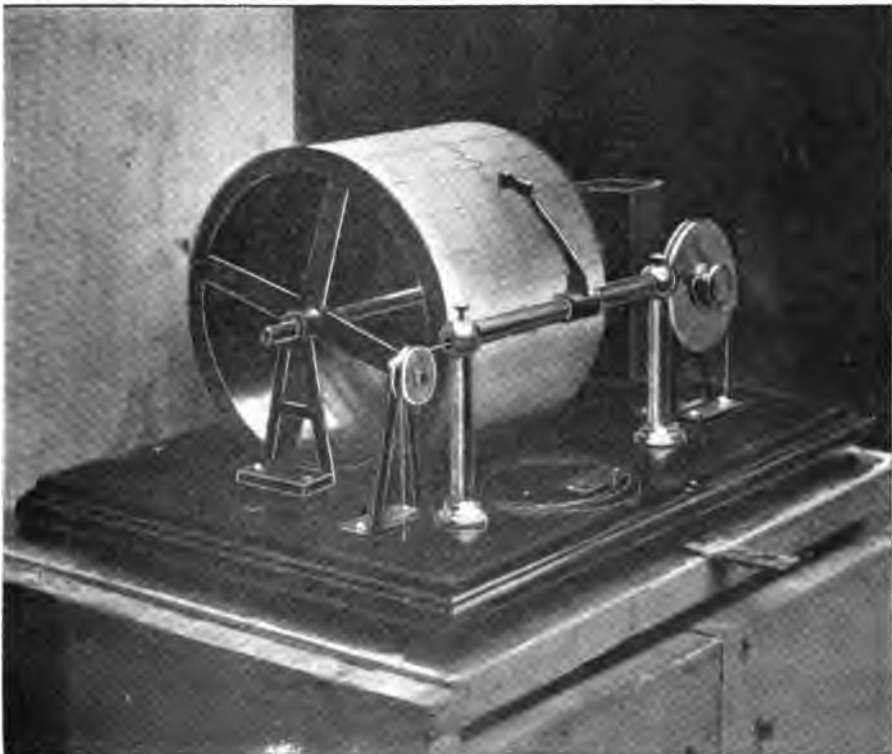
In the finished state the litter contains about 30 or 35 per cent. of moisture, and in this condition it goes into use. It is said to take up liquids more readily in this state than when the cells of the plants are completely deprived of water, and it is not so easily broken up under the feet of horses. The output of the factory is about 40 tons per day of ten hours, but can easily be increased. The consumption in America is about 18,000 tons a year at the present time, and the article has hitherto been imported exclusively from Europe. New York, Brooklyn, Boston, Baltimore, Philadelphia, Chicago, and other large cities, are the chief places of use in the United States, but the market for litter is rapidly growing. It is employed in the stables of milk and transportation companies, liverymen, and other large owners of cattle and horses, and even in the stables of many private individuals. The Canadian Peat Fuel Company has entered into a contract for supplying an average quantity of 22,000 tons per year, for five years, in the United States. They do not anticipate any trouble in marketing this quantity. One difficulty in the way of a more general use has been the cost of storing cargoes at the point of importation. Moss litter is a bulky article, and the rates charged for storage in large cities are high. These will be evaded in the case of the Welland factory, as the litter can be kept on hand there and shipped only as required to customers. The price at which it retails in New York is \$15 per ton. In London, England, it sells at 35 shillings per ton. The factory at Welland is the only one of the kind in America. The machinery used in it is from the designs of Mr. A. A. Dickson, the President of the company, and is patented in Canada, the United States, Great Britain, Germany, and other countries of Continental Europe. Beneath the layer of moss suitable for litter on the Welland bog, lies a very large quantity of dark, decomposed peat, which it is the intention of the company to manufacture into fuel. The depth of this peaty section varies from a foot or two, at the edge of the bog to 20 feet in the centre. The process of converting the crude peat into fuel is also one patented by Mr. Dickson, and, as now perfected, does away with the use of artificial heat. The peat is cut and air-dried, after which it is pulverized by being passed through a picker and automatically deposited in a hopper, which feeds a steel tube about two inches in diameter, and fifteen inches long. The pulverized peat is forced through this tube by pressure and formed into cylindrical blocks about three inches in length, almost equal in density to anthracite coal. This part of the business has not yet been brought into operation. Below the bed of peat lies a deposit of clay, which experiments have shown to be of fine quality for the manufacture of vitrified brick, pottery, etc. The prospect is that a very large business will be done by the company in the manufacture of moss litter, and, perhaps, eventually also in peat fuel. In the utilization of such dormant resources this company by its operations is really adding to the wealth of the community, and whether it can command success or not, it certainly deserves it.

THE GREAT LAKES AS A SENSITIVE BAROMETER. BY NAPIER DENISON, ESQ.,
TORONTO OBSERVATORY. [ILLUSTRATED.]

(Read February 6th, 1897.)

For many years fishermen and sailors upon our Great Lakes have noticed, with intense interest and curiosity, the rapid rise and fall of the water, most marked at the head of shallow lagoons, as at our Island, and have considered it to be an inexplicable phenomenon. While in the vicinity of Lake Huron last summer the writer's attention was attracted by what appeared to be a regular ebb and flow, at rapid intervals, at the mouths of rivers. At Kincardine, by means of a special float, a set of readings were taken, and a variation of level of over three inches obtained, averaging nine minutes (that is, eighteen minutes for a complete undulation); the float moving up stream at the rate of a mile and one-half per hour. Upon returning to Toronto, by permission of Mr. Stupart, Director of the Meteorological Service, a simple in-

FIG. 1.



strument was devised for automatically recording upon paper these peculiar oscillations, and was set up at the mouth of the Humber river.

The following is a brief description of this instrument (Fig. 1). It consists of a recording cylinder 24 inches in circumference and six inches wide, placed horizontal-

ly, which by means of clockwork completes one revolution every 24 hours, the hour intervals being, therefore, each one inch. Resting upon this cylinder is a self-inking pen, attached to an arm, which slides freely upon a horizontal tubular guide. To one side of this arm is fastened a silk line, which is attached to and wound several times around a small, grooved pulley, which is part of one four times its diameter. Upon the grooved circumference of the larger pulley is fastened another line, which, after several turns around it, passes down through the case to a float, enclosed in a special shaft, so constructed as to admit the water only through several small holes, and thus to prevent any sudden movement of the float being caused by local wave motion. To the other end of the sliding arm is fastened another line, which, after passing over a small grooved pulley (shown at the left of the illustration), descends through the case, and has attached to it a weight sufficient to balance the float. The record is obtained in the following manner: As the float rises and falls, the pen correspondingly moves up and down upon the paper, which is revolving at the rate of one inch per hour.

The ratio of movement between pen and float is as 1 to 4, so that an actual rise of one inch of water level corresponds to a movement of one-fourth of an inch upon the paper on the cylinder. To facilitate the measuring of these traces, one-quarter inch squared paper is used, the vertical lines marking fifteen-minute intervals, and the horizontal, one inch change in water level. To prevent the water from freezing in the shaft during the winter months, oil was used, which had the effect of depressing the water level below the frost line.

In order to increase the value of these records, a similar instrument was set up at the Burlington Canal last September. Before bringing before you some interesting tracings taken from these instruments, permit me to summarise previous investigations in other countries.

This phenomenon had been noted by Duillier as early as 1730, upon the Swiss lakes, where it obtained the name of *seiche*, owing to the apparent "drying up" or recession of the water upon one side of the lake, when rising at the other. In 1779 De Saussure remarks that he believes local variations in the air pressure may be the cause. In 1804 Vaucher published his researches on the subject. His conclusions are briefly as follows:—

- (1) Seiches more or less considerable occur in all lakes.
- (2) They occur at all seasons and at all hours, but most frequently in spring and autumn.
- (3) The condition of the atmosphere is the governing cause; the more settled this is the less are the seiches, and the more variable it is the more marked are they.
- (4) Although most frequent in spring and autumn, the greatest oscillations always occurred in July, August, or early in September.
- (5) Although the duration of these seiches is extremely variable, their intervals do not exceed 20 to 25 minutes, and are frequently less.
- (6) They varied much in amplitude at different points on the lake shores, being on the Lake of Geneva greatest at the mouth of the Rhone.

Vaucher supposed that the atmospheric pressure diminished over one part of the lake, while over another it remained constant or increased. If this change in pressure, occurred suddenly, the water which had thereby been set in motion would not come to rest again until after a number of oscillations.

Professor Forel agrees with this theory, which has also been accepted by Studer, Meyer and Favre. From 1854 to 1856 an important series of observations were made by six observers, placed at different points on the shore of Lake Geneva, who, using a system of signals to warn each other of the approach of an oscillation, noted the variations of the barometer and of the lake level. As Professor Forel in his article entirely disregards these barometric observations, they do not appear to have been published. In 1870 Professor Forel studied the seiches at the

Harbour of Morges, upon Lake Geneva, and obtained a mean of 4 min. 24 sec. for their total duration. At Geneva Vaucher's observations give a mean duration of 26 1-2 minutes. De Saussure and Duillier refer to seiches of 1 1-2 metres in amplitude, and M. Venie mentions one at Geneva of 2.14 metres, but usually they vary from about four inches to one foot. He (Forel) suggests that these are not true waves or progressive undulations of the water surface, but a movement of "oscillation of balance," or fixed oscillation, which may be both longitudinal and transverse. (Archives des Sciences Naturelles, Geneva, 1874.)

In 1876 Forel set up an automatic instrument to register these movements, and from records extending over four months, he deduced the existence of three varieties; intermediate, duration 25 minutes.

eties of seiche, viz: transverse, duration 10 minutes; longitudinal, duration 70 minutes. Upon this instrument he also observed movements of what he terms "vibration," caused (1) By steamers. The interval between these is from 9 to 60 times greater than that between ordinary waves, and they preceded the approach of a vessel by about 25 minutes, or when it was 9 1-2 kilometres distant, continuing for two or three hours afterwards.

(2) By wind, having no regular time or rhythm, and varying in amplitude from nothing to 10 millimetres, and in duration from 45 seconds to three or four minutes. He remarks that "sometimes there are little or none with a strong wind."

It may be mentioned that Guthrie has experimented upon this movement of oscillation, or balance in water, using, however, vessels in which the depth exceeded half the length, thereby eliminating the influence of depth altogether. (Proceedings Phys. Soc., Vol. I., 1875).

Lord Kelvin gives a theoretic law for the duration of these seiches in any lake, viz.: the semi-period of an oscillation is equal to the time that a body, travelling at the rate which it would acquire in falling from a height equal to half the mean depth of the lake would take to traverse the length of the lake. Thus, the duration of a seiche is proportional to the length of the lake, and inversely proportional to the square root of its mean depth. (Archives des Sciences Naturelles, Geneva, 1876). Applying this to Lake Ontario, and assuming the mean depth to be 300 feet, we obtain a theoretical duration for a longitudinal seiche, of over five hours. As will be shown later, the mean interval between the longest undulations, as taken from the Humber traces, is about 4 hours and 49 minutes.

In 1880 Professor Forel, in a letter, states that the smaller and more rapid oscillations may be accounted for by dividing the lake surface into more than one nodal point. (Archives des Sciences Naturelles, Geneva, 1880).

That you may more fully understand the following illustrations, it is necessary to become somewhat familiar with the movements of the upper atmosphere, where the chief cause of these lake oscillations is to be found. Permit me to quote a few lines from the late Professor Helmholtz, of Berlin (although previously cited in an earlier paper), who made a special study of atmospheric waves from theory, and analogy with ocean waves: "As soon as a lighter fluid lies above a denser one, with well-defined boundary, then, evidently, the conditions exist at this boundary for the origin and regular propagation of waves, such as we are familiar with on the surface of water. This case of waves, as ordinarily observed on the boundary surfaces between water and air, is only to be distinguished from the system that may exist between different strata of air, in that in the former the difference of density of the two fluids is much greater than in the latter case. Since the moderate winds that occur on the surface of the earth often cause water waves of a metre in length, therefore the same winds, acting upon a stratum of air of 10 degrees difference in temperature, maintain waves of from two to five kilometres in length. Larger ocean waves, from five to ten metres long, would correspond to atmospheric waves of from thirteen to thirty kilometres, such as would cover the whole sky of the observer, and would have the ground at a depth below them less than that of one wave-

length." He also states that "waves of smaller and smallest wave-length are theoretically possible."

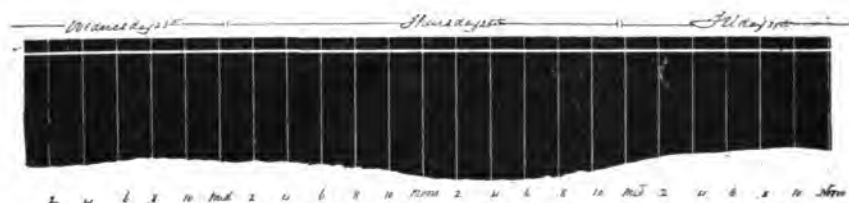
His theory is borne out by observations taken at the Blue Hill Observatory, near Boston, by Mr. Clayton, who has found that the larger waves, as marked upon the barograph traces, have a maximum frequency with northeasterly winds, and a minimum frequency when the wind is from the south-west, and also that the greatest number occur during the winter months.

Too much importance cannot be placed upon the above statements, as they are likely to prove of inestimable value in helping us to a better knowledge of the mysterious forces at work in the upper atmosphere.

In the accompanying diagram the upper, or poleward current, is represented as moving approximately from the south-west to the north-east, in its spiral course around the globe. Its average velocity is 60 miles per hour in summer, which increases to 112 miles per hour during the winter months.

The heavy lines indicate the lower stratum of air as travelling in an opposite direction to the upper current, which would be the case during the approach of a storm from the south-west. At the upper surface of this lower stratum huge atmospheric waves, or billows, are set up, due to the rapidly moving, opposing, upper poleward current of a lesser density. The influence of these huge waves often extends to the earth's surface, where they have been recorded upon barograph traces. The lighter lines represent a second form of wave movement in the lower stratum of air (say cumuli level), caused by the two subsidiary strata of the lower air travelling at different velocities and directions to one another, as is often observed during the approach of an important storm centre. These waves also extend to the earth's surface, where the larger ones are found recorded upon the barograph traces as short and rapid oscillations. These are well shown upon the Observatory photographic trace, now before us (Fig. 2), which is a record during

FIG. 2.

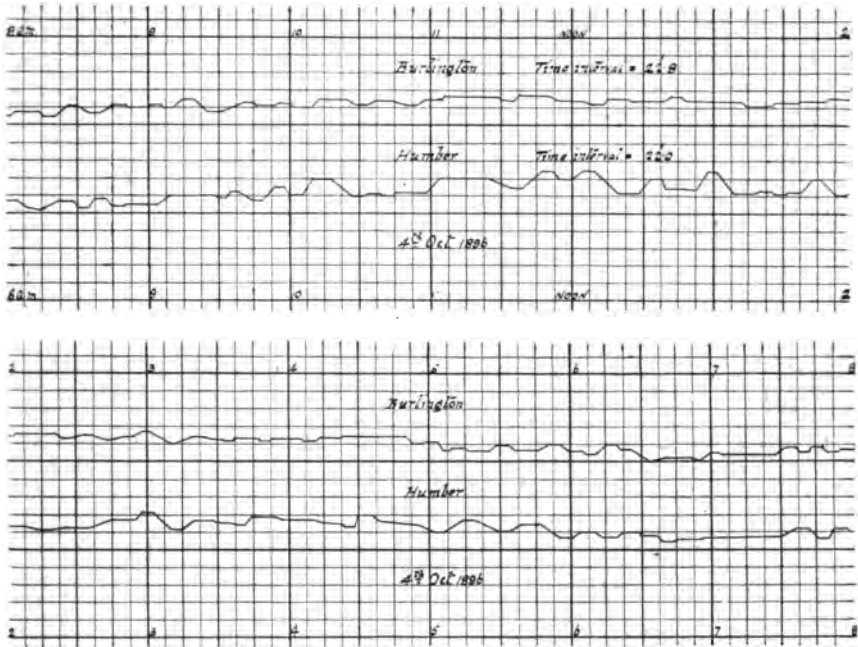


the approach of a storm from the south-west, upon which you will observe the larger undulations begin before the barometer falls, and are evidently caused by huge billows, set up at the boundary surfaces of the upper poleward current and the lower air stratum, which, owing to the position of the storm centre, would be rapidly moving in opposite directions. As the storm approached the undulations become more rapid, with a marked time interval of 10 minutes. These appear to correspond with the waves set up along the still lower, or cumulus level. As well as from the barometric record, the existence of these atmospheric waves, under certain conditions, may often be observed in the formation of the clouds above us; for instance, during fine, anti-cyclonic weather, one has frequently noticed great parallel bands of cirri appear in the west, and rapidly extend eastward, in advance of a cyclonic area, then over the Southern States. These represent the crests of the larger billows mentioned by Helmholtz, and are caused by the lower, denser stratum of air being forced up into a lighter and colder level, where condensation takes place. The following illustrations plainly demonstrate the existence of air waves found along the cumulus level. These forms, no doubt, are familiar to all present,

and, as you will observe, in the second one they are of such a regular character as to be commonly termed "roll cumulus."

Let us now examine the Burlington and Humber records for the 4th of October, 1896 (Fig. 3), during fine settled weather throughout the continent, plotted upon the same time sheet. As previously mentioned, these squares, when

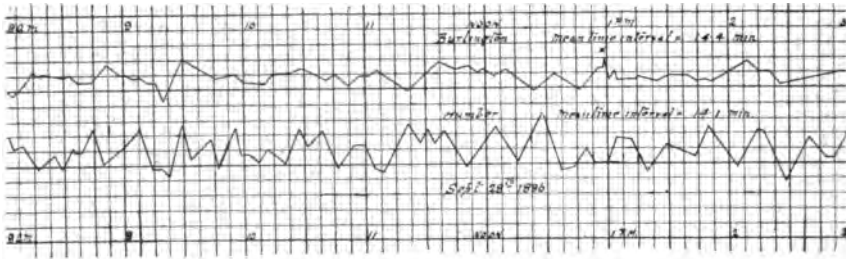
FIG. 3.



measured vertically, correspond to one inch change of water level, and, horizontally, to every fifteen minutes of time. It is interesting to note, not only the marked coincidence of these undulations, but the agreement of their time intervals, viz.: 22.8 and 22.0 mins. The greater amplitude of the Humber trace is due to the configuration of the adjacent shores and shallowness of the Bay. To obtain an idea of the prevailing atmospheric conditions, let us look at the morning and evening synchronous weather charts for this day. At 8 a.m. you will observe an important high area over Northern Ontario, while to the west of Lake Superior there is a well-defined area of low pressure. The weather is fine, and the direction of the wind northerly, throughout the lake region, but immediately to the westward the winds are from the southward. At 8 p.m. the high area has moved eastward, while the western low is dispersing over Lake Superior. As the winds have become southerly, the upper and lower strata of air are moving approximately in the same direction, therefore, according to Helmholtz, the upper atmosphere should be in an undisturbed condition. As a fair type of rapid undulations upon the lakes, during light winds and fine weather preceding a severe storm, let us take the Humber and Burlington traces from 8 a.m. to 3 p.m. of the 28th of September, last (Fig. 4). Here, again you will observe a decided coincidence between the two traces, and a wonderful agreement of time intervals, being 14.4 and 14.1 minutes respectively: also, the oscillations are much more rapid than when preceding settled weather. The movements upon the Humber instrument appear to be about double those upon the Burlington one. On the latter trace at 1 p.m. a peculiar rapid rise and fall of over an inch is seen, due to the passage of the Hamilton boat. In fact all vessels, large

and small, are duly registered upon this instrument. You see by this chart for 8 a.m. of the 28th that the centre of the storm which is causing these violent lake undulations is over the State of Florida, a distance of 1,300 miles from Toronto.

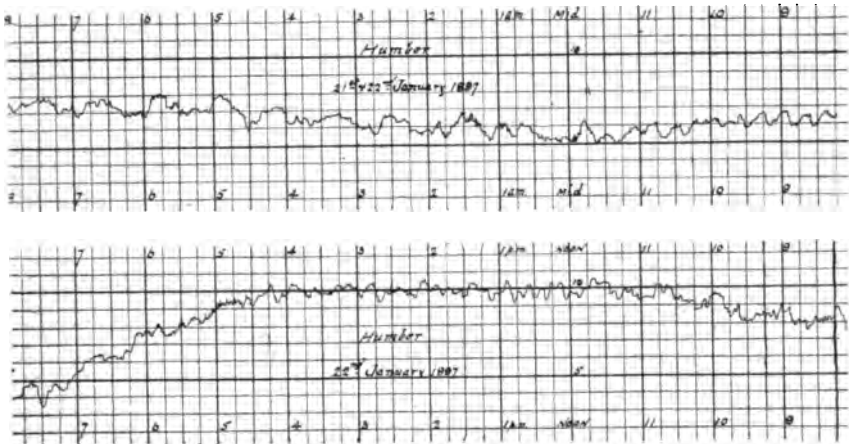
FIG. 4.



The lowest isobaric line, when drawn to tenths of an inch within this disturbance, was only 29.90, but owing to this time of year being favourable for the northerly movement of West India hurricanes, a careful watch was kept upon it by our forecast officer, who, finding after completing the 8 p.m. chart a slight development of this depression, warned all our lake stations for a heavy easterly gale. This chart for 8 a.m. of the 30th of September shows how the storm centre travelled slowly but directly to the lake region, where it caused a severe gale and a heavy general rainfall. To illustrate the value these lake instruments are likely to prove when studied in conjunction with the daily weather chart for assisting in the successful forecasting of precipitation as well as wind storms, let us examine the chart for 8 p.m. of the 19th of January last. Approaching the lake region from the north-west is a well-defined low area (centre about 29.70), while to the far south-west there is what appears to be a minor depression (centre about 30.00). Under such conditions it would be of great value to know if this latter area were going to develop and move towards us, as then it would be an easy matter to predict easterly winds with precipitation for the lake region, while, on the other hand, one would base their prediction upon the approaching north-west low, which usually gives southerly winds and fair milder weather. In this case, upon looking on the chart for 8 a.m. next day, you will observe the south-western low had developed, and was rapidly moving up the Mississippi valley, while the north-west low was quickly dispersing. The 8 p.m. chart for the 20th shows a still further development of the southern low, which has moved to the State of Ohio (centre. 29.70), while the northern depression appears to have completely dispersed, or to have been absorbed by the former. At 4 p.m. of this day it began to snow, and continued till next morning, when over six inches had fallen at Toronto, and a general snowfall prevailed throughout the lake region. A few days later, upon receiving the Humber records, marked abnormal oscillations were noticeable during the night of the 19th; also similar but minute undulations were found upon the Observatory photographic barograph trace. These records prove that, although the surface air was moving from the south, the upper or boundary surface of the lower air was rapidly moving southward, that is, in opposition to the superincumbent upper poleward current, therefore causing atmospheric waves or billows upon its boundary surface of sufficient magnitude to disturb the air nearest the earth. These lake records appear to prove conclusively, some time before the ordinary mercurial barometer and direction vane showed the change, that the southern low area was developing and the northern one dispersing. As the atmospheric conditions for the next few days are very much disturbed, and are followed by a most pronounced anti-cyclone and great cold in the North-west Territories, which eventually extended to the lakes, we shall look at a sequence of weather charts in conjunction with some very interesting Humber records. As

will be seen (Fig. 5) the trace began to rise at midnight of the 21st, and continued till noon of the 22nd, when it had risen over five inches; during this period large undulations of forty-five minutes' interval and from one and a half to two inches in amplitude are very marked. From noon to 4.15 p.m. the water level remained

FIG. 5.



stationary, while the oscillations became more rapid; then the water commenced to fall quickly, reaching its lowest point, a distance of nine inches, at 9.30 p.m., that is, in five hours and fifteen minutes. From this hour you will observe a decided undulatory curve, not merely due to the small rapid oscillations, but marked large undulations, whose average height from trough to crest equals three inches, with a mean time interval between crests of four hours and forty-nine minutes. (Fig. 7.) As previously stated, these appear to be the longitudinal "seiches" for our lake. From a careful study of the lake records from their beginning in July last this phenomenon is not to be found except at a time preceding or during tremendous atmospheric disturbances, similar to those at which we are about to look. In the present case this curious phenomenon lasted for three days, and was the precursor of a heavy northerly gale, which at this time of the year also means intense cold.

Let us hurriedly look at the weather charts during this period. At 8 p.m. of the 21st the low area which had given us snow had moved eastward, causing a snowstorm throughout the Maritime Provinces, while another depression lay east of Manitoba. In the far North-west an important high area, or anti-cyclone, had appeared. Qu'Appelle reported 10 degrees below zero and a heavy gale blowing. The water of the lake began to rise at midnight. By 8 a.m. of the 22nd the storm centre was over the State of Michigan, causing a high southerly wind with snow throughout Ontario, while the North-west anti-cyclone had developed and extended eastward, Winnipeg reporting 18 degrees below zero and a gale of forty miles per hour.

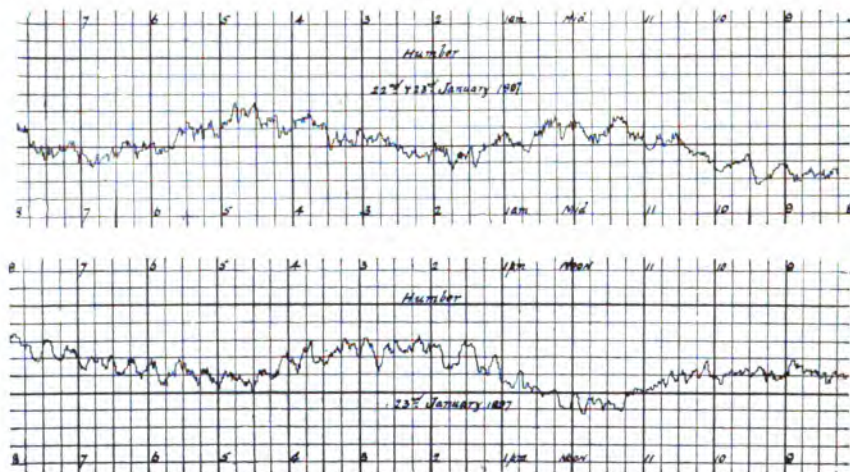
At 8 p.m. of the 22nd the wind was westerly in the lake region, but blowing a heavy gale. At 9.30 p.m. the water had reached its lowest point. At this hour these large undulations, or longitudinal "seiches," appeared, and were noticeable during the following three days. In the North-west the pressure was increasing and the temperature falling, while a heavy north-westerly gale prevailed from Manitoba to the lake region.

At 8 a.m. of the 23rd a north-westerly gale still was blowing over Ontario, while in the North-west the barometer had risen to over thirty-one inches, and the temperature fallen to 40 degrees below zero.

At 8 p.m. of this day Medicine Hat reported 52 degrees below zero. On the 24th and 25th the cold wave, though greatly diminished by lake influence, had reached Toronto, giving a minimum temperature of 8 degrees below zero.

After carefully measuring and tabulating the duration of the larger wave intervals taken from a great number of these lake records, it was surprising to find a

FIG. 6.



marked 20-minute interval. There appears to be a correspondence between these time intervals and those marked upon the barograph records for the same period.

Professor Forel suggests that the smaller, and more rapid oscillations observed upon the foregoing traces, may be due to the lake surface becoming divided into many nodal points of rest, similar to the nodes upon a violin string, when set vibrating. Although these researches cover too short a time to make any definite assertion, there seems to be a wonderful correspondence between the lake waves, as recorded at the Humber, and those found upon the Observatory photographic barograph traces. To illustrate this, let us look at the Humber record, plotted with the photographic barograph trace, during a thunderstorm on the 29th of July last. Here you will observe a marked coincidence between the two; that is, as the atmospheric pressure varied, so did the water rise and fall. The smaller and more rapid movements are not recorded upon the barograph, as it is not sufficiently sensitive. The sudden fluctuations and great range of water level preceding and during thunderstorms, are almost beyond conception until graphically shown, as before us. Here you will note, shortly after 4 p.m., a rise of water of five and a half inches in six minutes, followed by a fall of six inches in five minutes; the rise almost exactly corresponding to the crest of a decided barometric wave. This certainly points to local action, which would not be of sufficient extent to set the whole surface of the lake into multi-nodal vibrations.

These peculiar oscillations appear to be probably due to the action of atmospheric waves or billows, in passing over the surface of the lake, which tend to form minute undulations upon the surface, corresponding in length to these billows, and as they move farther into the bay, become magnified as they reach narrower and shallower portions, until, finally, they assume the proportions recorded upon the instrument. If not thus, how are we to account for the secondary undulations found upon the ocean tide gauges situated at the end of bays, where the shores cannot encircle the disturbed body of water, save at three sides at most? (1)

(1) "A Probable Solution of the Secondary Undulations Found Upon Tide Gauges." Read 16th January, 1897. *Supra*, p. 28.

As neither the ordinary mercurial nor aneroid barograph is sufficiently sensitive to record the more rapid and smaller atmospheric waves, I have devised, by Mr. Stupart's permission, a simple form of self-recording air barometer, which is seventeen times more sensitive. Most interesting results are now being obtained from this instrument, which may furnish material for a future paper.

To form some idea how sensitive even the photographic barograph is, you will notice two large and well-defined atmospheric undulations upon the trace before us. These are due to a great atmospheric wave, which was formed over Krakatoa, in the Indian Archipelago, during the tremendous eruption there, which caused such fearful loss of life and property in its vicinity. This catastrophe is vividly recalled to our memory by the brilliant red sunsets observed here for many months afterwards, caused by the volcanic dust in the air. This wave reached Toronto in fourteen hours, on its way to the antipodes of Krakatoa, from whence it was reflected back, repassing Toronto on its return, 8 hours and 20 minutes later. It was reflected back and forward, between its point of origin and antipodes, several times, leaving in all seven traces upon our barograph record.

Finally, permit me to draw a few conclusions in connection with what has been brought before you to-night. Meteorologists are unanimous that further advance or improvement in weather forecasting is not to be expected without a better knowledge of the movements of the upper atmosphere. The foregoing investigations seem likely to prove of service in this direction. In connection with the international system of cloud observations, now being carried on throughout the world, interesting and useful results might be obtained by careful observations of the undulatory forms assumed by clouds, and probably due to atmospheric billows, of the kind to which reference has been made to-night.

Since these peculiar undulations almost certainly occur upon all waters and lakes, large and small, if simple instruments, similar to that in use at the mouth of the Humber, were placed at several points on the shores of our great lakes; or, still better, if it were possible to have them in different parts of the world, and especially along a western seaboard, such as that of Great Britain, or our own British Columbian coast, results of great interest might be expected, and our knowledge of the extent, direction, and rate of movement of these atmospheric waves very greatly increased.

Fishermen also would find such instruments of great service, since their records furnish approximate indications of the probable force and direction of an approaching high wind. Already, those fishermen who live near the Humber have learned the advantages of consulting the records before going out to set their nets. A rise of the water level at the west end of the lake precedes, by many hours, the arrival of an easterly storm; as, on the other hand, a coming westerly wind is marked beforehand by a fall.

These phenomena are evidently due to differences of barometric pressure over the extremities of the lake, although, of course, at a later stage, the change of level is augmented by the direct action of the wind.

MINERALOGICAL NOTES ON SUDBURY ANTHRACITE. BY G. R. MICKLE, B.A.

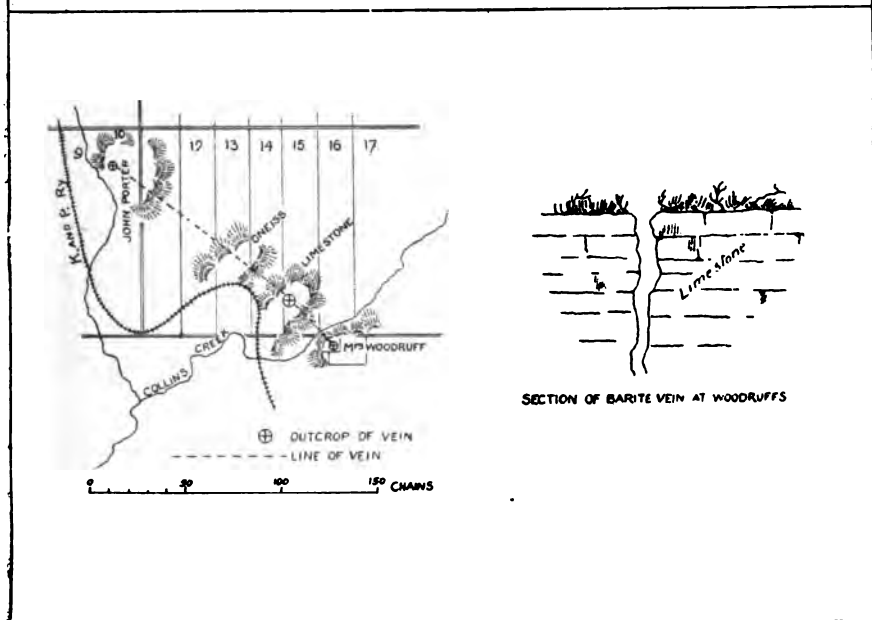
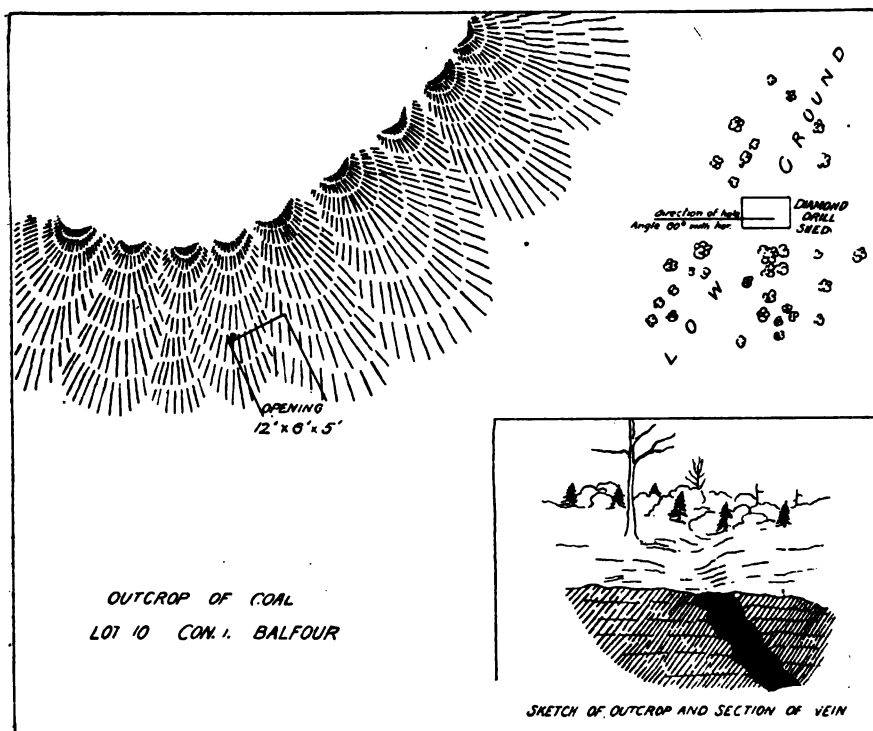
(Read February 27, 1897.)

On the map of the Sudbury District, published by the Geological Survey Department, an oval area about 8 miles wide and 30 miles long will be observed. This oval area is made up of a central part of "dark argillaceous and gritty sandstones" and a border of "blackish, siliceous volcanic breccia and black slate in places." The rocks found in this area are possibly Cambrian, but no fossils have been found to determine the age definitely. The deposit, or vein, which will be here described, is in the border. Another deposit or vein has been found about five miles further west, near the shore of Vermillion Lake.

The writer's attention was first called to this occurrence of coal-like substance early in June last year, when he made some preliminary tests on this peculiar mineral, which showed that it acted like anthracite. Shortly after this the surface soil was stripped off, and when visited by the writer, early in July, there was a considerable quantity of this mineral in sight. During the summer the vein was uncovered for about 70 feet, the average width being probably about 9 feet. The strike is about N. 20 degrees W., and the dip apparently about 45 degrees to E. Intermixed with the coal there is in places a considerable amount of quartz, and occasionally a little iron pyrites. The quartz forms, sometimes, a network, in which rectangular fragments of coal are imbedded; in other places the coal is almost free from quartz. If one of these rectangular fragments is partially burnt, and then examined by a glass, minute veins of quartz can be seen traversing it.

The mineral has a lustre like anthracite, only higher. Its hardness is between 3 and 4. This is considerably harder than ordinary anthracite, which is given as 2—2.5. The specific gravity, as determined by Mr. Lawson, is 1.865, the specific gravity of anthracite being 1.4—1.7; the average of ten commercial samples from the western middle coal fields of Pennsylvania was found to be 1.658; from the other coal fields of that State it was less (Penn. Geol. Survey, 1895, p. 1929). Some Rhode Island anthracite has specific gravity 1.81 (Dana). A mineral closely resembling this one was found in the Huronian formation near Lake Onega, in Russia. The lustre is described as adamantine metallic; hardness, 3.5-4; specific gravity, 1.84, and chemical composition similar to the Sudbury mineral (Naumann Mineralogie). The hardness and specific gravity of this interesting mineral from Sudbury are, therefore, on the extreme outer limit of anthracite. Another coal-like substance, which is shown in the sketch, is classed by Mr. Miller, of Kingston, as anthraxolite. Mr. Miller says: "The anthraxolite which I sent was collected by me 'in situ,' about six miles north of this city. It occurs in a vein which has been worked for barite on the farm of John Woodruff, the north part of lots 16 and 17, in fourth concession of the Township of Kingston. The vein, which is nearly vertical, is about 2 1-2 feet wide, and cuts the limestone of the Black River formation of the Silurian system. This limestone is very fine grained, and lithographic in character, and forms a comparatively thin layer over the Laurentian gneiss, which is exposed at places in the valleys. The most abundant mineral in the vein is barite, but calcite and fluorite are also found, as well as anthraxolite. This vein can be traced across country for over one and a half miles in the limestone; it is, however, not found in the valleys where gneiss is exposed.

The anthraxolite has been deposited after the barite and other minerals, as it coats them and fills crevices in them. It is probable it has been derived from the



bituminous matter in the limestone. Crystals of fluorite in the Niagara limestone have been found which enclosed small amounts of petroleum."

This anthraxolite of Mr. Miller's has a duller lustre than the Sudbury mineral, has conchoidal fracture, and resembles bituminous coal more in appearance. It is considerably softer than the Sudbury mineral; its specific gravity is 1.365, and, chemically, it is entirely different. The anthraxolite described by Chapman is "black, lustrous, resembling anthracite in general characters, but very brittle. H. 2.25—2.5; specific gravity, 1.35—1.55; generally decrepitates when heated B.B., a small fragment loses its lustre, but exhibits no further change. Composition essentially carbon, with from 3 to 5 per cent. volatile matter, including a small amount of moisture. The ash, as at present observed, varies from 0 to 10 per cent. When present it exhibits under the microscope no trace of organic structure. This substance, in all probability a product of alteration from petroleum or asphalt, occurs in narrow veins in rocks of various kinds, and in small masses and thin layers or coatings in strata of the Utica and other formations. * * * As it differs essentially by these conditions of occurrence from anthracite proper, the name anthraxolite has been given to it, but simply as a convenient term for present use." (Chapman, *Min. and Geol., Ont. and Que.*, 3rd ed., p.143.) The Kingston mineral is evidently the anthraxolite of Chapman. An analogous occurrence of coal in a vein and not in a bed, and which shows no trace of vegetable origin, is the well-known Albertite of New Brunswick, in appearance, specific gravity and chemical composition widely different from the Sudbury coal. Messrs. Bailey and Ells say in their report: "There can, we think, no longer exist a doubt that the deposit here so extensively worked is a true vein, occupying irregular fissures among highly disturbed strata, and in no way presenting any analogy to an ordinary coal bed." They regarded Albertite as an altered petroleum. This Albertite was discovered in 1849, had its maximum production in 1863-5, when 17,000 tons were produced annually, and in 1876-7 was producing 6,000 tons; the depth was then 1,260 feet, and a trial hole put down 100 feet further showed its continuance. In extent the vein was 2,800 feet long, and was very irregular in size, thickening from a few inches to ten or fifteen feet in a few yards, and much fractured and broken by faults. (*Geol. Sur. Rep.*, 1876-7, pp. 368-388.)

With regard to the origin of the Sudbury anthracite, which occurs in quantities which compel attention, its presence in rocks which are supposed to belong to the Cambrian period, and in which no fossils or traces of vegetable remains have ever been discovered, is very surprising, and cannot be accounted for by the usual theory of the formation of coal from vegetable matter. There are two absolute facts which should be kept in mind, and our theories should be moulded to suit them. In the first place, this mineral occurs certainly in quantities of some hundreds, probably thousands, and possibly an indefinite number of tons; and secondly, the chemical analysis and physical characteristics agree with some anthracites closely: it has, in fact, become more anthracitic than most anthracites. The conclusion which is inevitably forced upon one is that coal can be formed in some other way than by decomposition of vegetable matter. Possibly the development of these veins or deposits will throw some light on this subject.

NORR.—The sketch of the Sudbury deposit or vein was made by Mr. J. W. Evans, and the sketch of the Kingston vein by Mr. W. G. Miller.

CHEMICAL NOTES ON THE SO-CALLED SUDBURY COAL. BY W. HODGSON ELLIS, M.A., M.B., AND WM. LAWSON, B.A.Sc.

(Read February 27, 1897.)

Prof. E. J. Chapman has described (Canadian Journal, Vol. X., p. 410) a vein of anthracite from the lower copper-bearing rocks of Lake Superior, an analysis of which gave :

Moisture	2.08
Volatile matter	3.56
Fixed carbon	94.36
Ash	0.00
<hr/>	
100.00	

In his "Minerals and Geology of Central Canada" Chapman applied the name "Anthraxolite" to this and similar substances occurring "in veins, with quartz, in the altered strata of Lotbiniere, in the Eastern Townships, and also in regularly banded veins with quartz and iron pyrites on Thunder Bay, Lake Superior" and elsewhere. He regarded it, probably justly, as a "product of alteration from petroleum or asphalt."

In Bulletin No. 2 of the Ontario Bureau of Mines on "Anthracitic Carbon, or Anthraxolite," Dr. A. P. Coleman describes a coaly deposit occurring in a vein in slate in Balfour Township, near Sudbury, to which he applies Chapman's name of Anthraxolite.

We have received specimens of this substance from Mr. Blue, Director of the Bureau of Mines, from Mr. J. M. Clark, from Dr. Coleman, and from Mr. G. R. Mickle, which we have submitted to chemical examination. The samples differ greatly with regard to the amount of minerals, chiefly quartz, with a little iron pyrites, associated with the coaly substance, on which account the ash varies greatly. We found 36.5 per cent., 30 per cent. and 20 per cent. of ash in different samples given us, otherwise the composition of the substance is quite uniform.

The following is the proximate analysis of an average and of a selected sample :

	Average.	Selected.
Moisture	4.00	4.00
Volatile matter.....	1.30	1.80
Fixed carbon	74.20	90.10
Ash	20.50	4.10
<hr/>		<hr/>
100.00		100.00

We have also made an ultimate analysis of a carefully-picked specimen, freed as much as possible from associated quartz, etc. The following are our results :

	I.	II.	Mean.
Carbon	94.90	94.94	94.92
Hydrogen.....	0.55	0.48	0.52
Nitrogen	1.04	1.04	1.04
Sulphur	0.30	0.33	0.31
Ash	1.54	1.50	1.52
Oxygen, by difference	1.67	1.71	1.69
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100.00		100.00	100.00

The specimen contained 2.48 per cent. hygroscopic moisture. Its specific gravity was 1.865.

The combustion was made in a current of oxygen, the nitrogen was determined by Dumas' method, and the sulphur by Nakamura's method.

The striking characteristic of the mineral, as shown by this analysis, is the very small percentage of hydrogen it contains, a quantity much less than that contained in ordinary anthracite.

With a view to comparison we made an analysis of a specimen of anthraxolite from Woodruff's farm, near Kingston, kindly given us by Mr. W. G. Miller, of the Kingston School of Mining. The specific gravity of this mineral was 1.365; it contained 0.96 per cent. of moisture. The analysis of the dry substance gave:

	I.	II.	Mean.
Carbon	90.27	90.23	90.25
Hydrogen.....	4.18	4.14	4.16
Nitrogen	0.52	0.52	0.52
Sulphur.....	0.66	0.66	0.66
Ash	0.63	0.80	0.72
Oxygen, by difference	3.74	3.65	3.69
	100.00	100.00	100.00

In this sample the percentage of hydrogen is higher than in most anthracites, and very much higher than in the Sudbury mineral, which, indeed, differs from it as much as the average anthracite differs from bituminous coal.

We have determined the calorific value of the Sudbury "coal" by means of Fischer's calorimeter. We found that one gramme of a sample containing 3.99 per cent. of ash gave on burning 7,490 calories. This will give a calorific value of 7,800 for the ashless fuel.

On the large scale, so far as the deposit has yet been examined, the ash runs from 20 to 30 per cent. The calorific value will, therefore, be correspondingly lower.

THE CONSTRUCTIONS WITH REFERT AND INTEREST. BY PROF. A. J. BELL,
PH.D.

(Read February 28th, 1897.)

The constructions in question are thus described in "Allen and Greenough's Latin Grammar":

"The impersonals *interest* and *refert* take the genitive of the person, rarely of the thing, affected,—the subject of the verb, being a neuter pronoun or a substantive clause, as *Clodii intererat Milonem perire* (Cic. in Mil., 21).

(a) Instead of the genitive of a personal pronoun the corresponding possessive is used in the ablative singular feminine after *interest* and *refert*: as *quid tua id refert?*—*magni* (Ter. Ph.); *vehementer intererat vestra qui patres estis* (Plin.).

(b) The accusative with *ad* is used to express the thing with reference to which one is interested: as *magni ad honorem nostrum interest*" (Fam. XVI. 1).

The question is: How is it that, while the person interested is expressed by the genitive of the substantive in *Clodii interest* or *eius refert*, it is expressed by the ablative singular feminine of the possessive adjective in *mea interest* or *tua refert*, while the thing concerned is expressed by the accusative with *ad* in *ad honorem nostrum interest*? Indeed, the question is really somewhat more involved; for in the last construction, instead of the accusative with *ad* we find the dative: as in *non referre dedecori* (Tac. Ann. 15.65.), and the dative is also used instead of the genitive to express the person interested: as in *quid refert intra naturæ fines viventi* (Hor. Sat. I. 1. 49.). Indeed the distinction given regarding persons and things, while the rule, is not universal: cf. *multum interesse rei familiaris tuæ* (Cic. ad Fam. 4. 10. 2.) with *quid id ad me aut ad meam rem refert* (Pl. Persa. 513), and in this inquiry we may disregard this distinction. There is, as yet, no agreement among grammarians about the solution of this question, though what seem to me to be correct solutions of the main difficulties involved have been stated or suggested by some of them.

Of the constructions mentioned above, those represented by *mea refert* or *mea interest* and *illorum refert* or *illorum interest* have always been felt to be the cardinal ones, those on the solution of which a correct understanding of the nature of the remaining constructions depends. And first let us notice some of the solutions that have been proposed. Donatus, whose grammar was the text-book of the Middle Ages, in a note on *Quid tua, malum, id refert?* (Ter. Ph. 753) suggests that *tua* is for *ad tua*; and his explanation is evidently based on the idea naturally occurring to anyone who examines these constructions, that, whatever constructions are in fact found with *refert* and *interest*, the dative is the case we should expect to find dependent on them. But in Donatus' day, in the first half of the fourth century of our era, in ordinary thought and conversation the dative had in all likelihood been supplanted by the accusative with *ad*, the construction that takes its place in the Romance Languages. A like view seems to have been in the mind of Scaliger, when he explained *tua nil refert* as equivalent to *tuas res non repræsentat*, i.e., *affert*. Sanctius, the famous Jesuit grammarian, and Ruddiman agree in thinking *tua* here an accusative; but Sanctius prefers to make *mea interest*, the more usual form of expression in Golden Latinity, his starting point, and explains it as equivalent to *est inter mea*. Vossius and Bentley showed that *mea* here could not be the accusative as the *a* is long, and the view was abandoned. It was revived, however, in our day by Emanuel Hoffmann, who, in a paper in the *Jahrbuch für Philologie* for 1878, suggests that *mea interest* is equivalent to *est inter mea*, and explains *interest omnium* as equivalent to *est inter omnium*, proceeding from a consideration of such phrases as *in Dianæ, ad*

Carmentis,—phrases in which he would not supply an accusative. But the quantity of the *a* in *mea* seems fatal to his view.

Priscian thinks of *mea* in *mea refert* as ablative, and would supply *in re*, making the full construction *mea in re refert* equivalent in meaning to *in mea utilitate refert*. In this he is followed by Valla, but Sanctius denies that *mca in re* can have this meaning; and Vossius, who thinks with Priscian that *mea* is ablative, prefers to supply *causa* or *gratia*. Later supporters of the view that *mea* is ablative—such as Reisig, Krueger and Schmalz—recognize that in the first syllable of *refert* the *e* is long, and that it is properly written as two words, *re fert*; and from the analogy of the Plautine phrase, *e re mea* “to my advantage,” they explain *mea refert* as for *e mea re fert*, “it bears to my advantage.” This explanation, which is the one now usually adopted, while it is a possible one, has no support from the ancients, and affords no explanation for the constructions in *referi viventi* or *ad me refert* quoted above.

A third explanation given by the Romans, and the oldest of all, is that found in Festus' Compendium of Verrius Flaccus' work, “*De Significatu Verborum*,” where we read (p. 282 M.) “*Refert cum dicimus, errare nos ait Verrius; esse enim rectum reifert, dativo scilicet, non ablativo casu; sed esse jam usu possessum.*” That is to say, in the phrase *mea re fert*, Verrius thinks *mea re* primarily a dative and equivalent to *mea rei*, but acknowledges that the words in question are—*jam usu possessum*—generally acknowledged to be ablatives, on account of their form, the identity of which with the ablative is obvious, while into their real and primary nature few pause to inquire. But Verrius was one of the few men who make it their business to inquire into the real nature of such phrases, and of all Romans who engaged in such investigations, his authority best deserves our attention. He lived in the reign of Augustus, who appointed him tutor to his grandsons, Gaius and Lucius Cæsar; and from the epitomes of his work, “*De Significatu Verborum*,” made by Festus and Paulus Diaconus, we can see that it was an exhaustive dictionary of Archaic Latin, made at a time when materials were best available for such a work. Gerard Vossius feels the weight of his authority, and is willing to acknowledge that *refert* may be for *rei fert*, being probably influenced by Cæsar's statement that the proper and usual endings of the dative singular in the fourth and fifth declensions is not *ui* and *ei*, as given in the compendia of later grammarians, and as written by later scribes, but *u* and *e*. But *mea*, Vossius thinks, cannot be the dative, and for this reason he rejects Verrius' explanation. But, in the light of the testimony afforded by older Latin inscriptions, Vossius' reason for rejecting this explanation becomes, it seems to me, our strongest reason for accepting it. In the first volume of the *Corpus Inscriptionum Latinarum* we find eleven instances of undoubted datives of the first declension ending, not in *ae*, but in *a*, as for example in *Fortuna dedi* or *matre matuta dono dedro*. W. M. Lindsay, in a paper in the *Classical Review* of December last, recognizes in old Latin two forms of the dative singular for *a* stems, represented by *Fortunai* and *Fortuna*, both derived from the primary *Fortuna + ai*, but for the differentiation of which he cannot account. So we find for *o* stems two forms of the dative in old Latin, *populoi* and *populo*, both derived from the primary *populo + ai*; but here it is the shortened form that has held the field. *Mea re* is, then, if we accept the testimony of Cæsar, and of the oldest inscriptions, as good a dative as *mea rei*; and *mea re fert* is, according to our oldest authority, equivalent to *mea rei fert*, “it bears to the advantage of my affair”; which is precisely the explanation of the meaning of the phrase now generally accepted, but attained without resorting to the Jesuit's trick of the ellipsis, and presenting us with a noteworthy confirmation of the latest view with regard to the form of the dative in Archaic Latin. This explanation seems to me, moreover, to be confirmed by some of the parallel constructions that are in use for *mea*, the ablative so-called. Horace, as we have seen, wrote *re fert viventi*, using an undoubted dative. As far back as Plautus we find, used as a substitute for the dative, the preposition *ad* with the accusative, which takes its place in the Romance languages. And it is

used as a substitute for *mea* in *mea refert*, for we read in Plautus, *quid id ad me aut ad meam refert* (Persa. 513). Two of the constructions, then, that can take the place of *mea*, in *mea refert*, are the dative itself and the ordinary substitute for the dative, a fact strongly confirming Verrius' view that *mea* here is itself a dative.

But what of the genitive with *refert*. It appears much later than the genitive with *interest*, belonging properly to Silver Latinity, while the genitive with *interest* is very common in the Golden Latinity of Cicero. No instance of a genitive, other than the genitive of value, is found in Archaic Latin in connection with *interest* or *refert*, if we except the following example in the Lex Acilia Repetundarum (C. I. L. 198. 32), *quod eius rei quaerundai censeant refere*, where the genitive *eius rei quaerundai* is certainly not parallel to that in *eius interest* or *illorum refert*, but seems rather a predicative use of the genitive of characteristic, parallel to *imperium regium quod initio conservanda libertatis fuerat* (Sall. Cat. 6, 7). If this is correct, the use of the genitive with *refert* is the older construction of the two. Hoffmann's view as to its origin we have already noticed, and he is certainly correct in thinking that it cannot be connected in origin with the older construction of the dative with *interesse* in its personal use, as in *interfui praelio*. An example in Cicero (ad Fam. 4. 10. 2), *suspicerer multum interesse rei familiaris tuae*, leads Schmalz to explain it as primarily a partitive genitive, and he evidently understands the passage as meaning, "I should suspect that much of your estate was involved." But this is not a typical example of the construction, being a genitive of the thing, not of the person. Most probable seems a solution suggested to me by Mommsen's version of the Lex Acilia, and which I find hinted at in Allen & Greenough's Grammar (P. 222 Remark), that the genitive with *interest* is formed after the analogy of the predicative genitive with *est*. The analogy, is, perhaps, best stated in the following way: The idea of possession is originally distinct, in the mind of the Romans, from that of ownership, but later by *usucapio*, i.e., by possession for a number of years, two at most in Gaius' day, ownership is acquired. *Res est alicuius (jure Quiritium)* is the Roman formula for ownership; *res est alicui (in bonis)*, that denoting possession. But what of the thing that, being in the possession of anyone, is passing into his ownership? Can we say, *Res fit alicuius*? We read in the Lex Acilia (66), *res populi fiet*. Did the Roman, then, come to feel that, in the thing then in his possession and passing into his ownership, he had any proprietary right? Gaius speaks of a thing as being subject to a *duplex dominium*, that of the person in whose *potestas* it is,—its owner in the proper sense,—and that of the person in whose *possessio* it is, and into whose *potestas* it is consequently passing. It seems to be this latter *dominium* which finds its expression in the phrase *interest alicuius*. Or, to put it more briefly, *est Marci* means "it is the property of Marcus"; *fit Marci*, "it is becoming the property of Marcus"; *interest Marci*, "it partly belongs to Marcus," or "Marcus has a proprietary interest in it,"—a meaning closely related to the usual meaning of *interest eius*. That *refert*, as early as Plautus' day, was not regarded as two separate words, but as one, is clear from such a construction as *quae ad rem referunt* (Persa, 591), or *quoi rei te adsimulare refert* (Truc., 394). In Cicero's day its meaning differs but little, if at all, from that of *interest*. In such an assimilation of meaning the influence of analogy usually leads to a confusion of constructions originally distinct. The way in which this influence would work may be stated as follows: *refert*=*interest*, therefore *mea refert*=*mea interest*; and so for *mea refert*, the only form occurring in Archaic Latin, *mea interest* comes into use in Cicero's time. In like manner *interest*=*refert*, therefore *omnium interest*=*omnium refert*; and so beside *interest* with the genitive, the usual construction in the Golden Latinity, there appears in Silver Latinity the genitive with *refert*. And as *interest* has thus acquired a regimen that is primarily and really a dative, it is not strange to find it joined with a construction commonly used as a substitute for the dative, viz. the accusative with *ad*, as in *ad honorem nostrum interest*. That it is never joined with the dative itself, is probably due to a fear of confusion with the ordinary personal use of *interest* in *interfui epulis*.

THE OCCURRENCE OF RABIES IN ONTARIO. BY J. J. MACKENZIE, B.A.,
BACTERIOLOGIST TO THE PROVINCIAL BOARD OF HEALTH.

(Read December 12, 1896.)

There is good evidence that there have been at least five outbreaks of this disease in Ontario since 1890. We have knowledge of eight individuals having been bitten by rabid dogs and having been subsequently treated at the Pasteur Institute, New York. A study of the Registrar General's returns for the Province of Ontario since Confederation does not show that rabies has ever been set down as a cause of death.

The evidence that rabies occurs in Ontario rests chiefly upon the results of inoculations made upon rabbits in the Laboratory of the Provincial Board of Health, in the case of an outbreak in the County of Middlesex, in 1895, and another in the town of Paris in 1896.

It has not been possible to trace any connection between these various outbreaks, although it seems probable that the one which occurred in Paris, in 1896, was preceded by one in 1895, in the district surrounding that town. This outbreak, however, was not investigated.

The question as to the origin of the disease in Ontario is a difficult one to decide. It does not seem probable that it is due to wild animals, as all the outbreaks occurred in the southern and older parts of the Province. It is more likely due to the introduction of the virus in imported dogs, chiefly from the United States.

In regard to the prevention of the disease, it seems as if the destruction of masterless dogs and the enforcement of a muzzling law for some months after an outbreak in any district in which it occurs would be sufficient.

A general muzzling law cannot be regarded as necessary.

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NOTE ON SCIRPUS DEBILIS AND SCIRPUS SMITHII. BY WM. SCOTT, B.A.,
VICE-PRINCIPAL OF THE TORONTO NORMAL SCHOOL.

(Read March 13, 1897.)

These two species were found by me last season. This is the first record of these plants being found in Canada. *S. debilis*, Pursh, was found growing in a ditch on the railroad near Queenston Heights, and *S. Smithii*, Gray, was growing on Toronto Island.

Regarding these two plants, N. L. Britton and A. Brown, in their "Illustrated Flora," say of *S. Smithii*: "Perhaps only a form of the preceding, *S. debilis*." A careful study leads me to the conclusion that they are entirely distinct species:

(1) Their mode of growth is very different. *S. Smithii* grew in detached plants, and tillered from the root like grain. *S. debilis* grew in clumps. Many plants were clustered together. Careful search on various occasions was made, but no isolated plants could be found in the one case and no clustered ones in the other.

(2) The involucreal leaf is almost a prolongation of the culm in *Smithii*; in *debilis* it is very divergent. It is almost always turned at right angles to the culm.

(3) In *Smithii* the scales are oblong; in *debilis* they are oval or elliptical.

(4) In *Smithii* the seeds are brown obovate, flattened, and have no glossy appearance. In *debilis* they are black, broadly obovate, rounded, and are glossy. Under a lens they are as easily separated as barley and wheat with the naked eye.

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RECENT CONTRIBUTIONS TO GAELIC AND MANX LITERATURES. BY REV.
NEIL MACNISH, B.D., LL.D.

(Read March 20, 1897).

A veritable Renaissance has in recent years been observable in the study of Gaelic and of Gaelic literature. Never since Fingal was King of Seallama, and since Malvina gladdened the declining years of Ossian, has so much attention been paid to Gaelic, and to Gaelic traditions and folk-lore; and have so many men of scholarly ability and taste devoted themselves to the study, and, indeed, to the development of Gaelic. For it has always been conceded that Gaelic possesses intrinsic qualities of an extraordinary kind; and that, therefore, it can, in able hands, take on beautiful and diversified forms and developments. Evolution, in the truest acceptation of the term, is characteristic of Gaelic; insomuch that, were scholars of ability and ingenuity to turn their careful attention to it, it could continuously assume larger and wider proportions. Such a momentum in favour of the language and literature of the Gael has now been gathered, that anything like retrogression is not to be apprehended, so far as regard is had to the production of Gaelic poetry and prose. Eisteddfod is the appellation that is given to the annual gatherings of the Welsh—which, having their origin in the unrecorded past, call forth unabated enthusiasm wherever they are held. Prizes are wont to be given which are very much appreciated, as they deserve to be, for superior excellence in prose and verse; in vocal and instrumental music, and in other avenues of intellectual effort and research in connection with the history and language of the Cymri. The Gaels of Scotland have been very slow in instituting any gatherings similar to the Welsh Eisteddfod. Regrets are now unavailing, that the other members of the large Celtic family did not, centuries ago, follow the example of the Welsh in the way of holding annual gatherings for the honouring and perpetuating, in healthful and ever-increasing vitality, of their own particular language with all its literature, and with all its traditions, that could in that case be found to pertain to it. Had such gatherings been in existence for centuries, it may be confidently maintained that Scottish and Irish Gaelic as well would to-day have treasures of valuable literature in prose and verse of which too high an opinion could not be formed;—treasures which, unhappily, have sunk into the deep sea of forgetfulness. Much praise is to be awarded to those intelligent and enthusiastic Gaels, who were successful some six years ago in establishing the Gaelic Mod,—an annual gathering at which prizes are given, after the example of the Welsh Eisteddfod, for the best productions in Gaelic prose and verse, in vocal and instrumental music, as well as in other attainments of a literary and artistic character.

The fifth Mod was held in October of last year in Perth. It was very successful. Unmistakable indications are available that the Mod is growing in popular esteem, and that it promises fairly to intensify the ardour of Gaels for their language and their traditions, and thereby to subserve the patriotic and very commendable purpose which its founders had in contemplation. The next Mod is to be held in Inverness, which possesses the best and most intellectual Gaelic Society in the world—a Society that has already published some twenty volumes of Transactions, which contain papers of a very instructive character, dealing, as they do, with an extensive variety of Gaelic subjects.

In the centuries that have gone, there must have been a continuous intimacy between the Gaels of Ireland and the Gaels of Scotland. A reciprocal influence must have been thus created in the development of the literature and customs of the Irish and Scottish Gaels.

"Ultonian Hero Ballads, collected in the Highlands and Western Isles of Scotland from the year 1510 and at successive periods till 1870"; such is the designation of a book which was published some time ago by Hector MacLean, under the auspices of the Islay Association. The Gaels of Islay evince a laudable willingness and liberality to honour and befriend any native of their island who succeeds in making a name for himself in the domain of Gaelic learning. To that number belonged the late Hector MacLean, who arranged and translated the Ultonian Hero Ballads. He has rendered in other respects important services to the cause of Gaelic literature. He was an able coadjutor of the late Mr. Campbell, who compiled "*Leabhar na Feinne*." "The large amount," Mr. MacLean writes, "of Irish Saga literature belonging to the Ultonian cycle dates in its form back to the tenth century, and there is MS. tradition of part of it extending back to the seventh century. Different forms of the same Saga can be discriminated as far back as there are means of research, and these Sagas have undergone the same harmonising process, but not the same euhemerising process as the earliest annals. The same mediaeval school was conspicuous in this one case as in the other. These ballads have for many centuries been sung and rehearsed in the Highlands." Mr. MacLean has made an important beginning in investigating a department of literature which concerns Irish and Scottish Gaels alike, and which demands much more extensive study than it has yet received.

Iain Lom MacDonald is one of the most talented and satirical poets in the entire range of Gaelic poetry. The largest and best collection of the poems of this famous bard was published some time ago in Antigonish, Nova Scotia. The Rev. A. MacLean Sinclair, who prepared the collection in question, has already gained for himself a great reputation for his unremitting devotion to Gaelic literature, and to the perpetuation of Gaelic poetry. He takes an affecting leave of his labours in behalf of Iain Lom in these words: "*Beannachd leat Iain Luim, chuir mise d'orain a mach cho maith 's cho ceart 's a b' urrann mi. Tha mian doch as gu tig aon eiginn am dheigh a ni na's fhearr.*"

"*Lyra Celtica*" is the name of an anthology of representative Celtic poetry, which is edited by Elizabeth A. Sharp, with an introduction and notes by William Sharp. The "*Lyra Celtica*" was published during 1896. It is a large, varied and interesting collection of Celtic poetry, containing, as it does, ancient Irish and Scottish poems, ancient Cornish and early Armorican poems, early Cymric and mediaeval Welsh; Irish modern and contemporary Scotto-Celtic (middle period), modern and contemporary Scotto-Celtic, contemporary Anglo-Celtic poets (Wales), contemporary Anglo-Celtic poets (Manx), contemporary Anglo-Celtic poets (Cornish), modern contemporary Breton, the Celtic Fringe. Miss Sharp has accordingly travelled over a very extensive field in her desire to gather poetical flowers for her Celtic anthology. It is remarked in the preface, that the volume "is no more than an early, and in a sense merely arbitrary, gleaning from an abundant harvest."

Of recent years, we have had many works of the greatest value in Celtic ethnology, philology, history, archaeology, art, legendary ballads and romance, folk-lore and literature. In the national libraries of Great Britain alone it is estimated that if all the unedited MSS. were printed, they would fill at least 1,200 or 1,400 octavo volumes. Though the songs and poems and ballads that the "*Lyra Celtica*" contains appear in an English dress, it is possible, however, for the student to discern the peculiarities of the mind and heart, of the thoughts and feelings, customs and manners of the various Celtic races. There are to be found

side by side in the "Lyra Celtica" translations of the songs and poems that were wont to be sung and to be admired in distant days of Celtic warfare and exploits by Welsh and Cornish and Armorican Celts, and by Irish and Scottish Gaels and Manxmen. There must be those who, elated by the strong vitality which is pulsating now through the arteries and veins of the Celtic races, will call in question the accuracy of the statement "that the Celtic race stands now with averted torch, and the light of it is a glory before the eyes, and the flame of it is blown into the hearts of the mightier conquering people. The Celt falls, but his spirit rises in the heart and in the brain of the Anglo-Celtic peoples with whom are the destinies of the generations to come."

It must be regarded as a strong indication of the present vitality of the Gaelic language that a translation of the Book of Common Prayer into Gaelic, for the benefit of the Gaelic members of the Scottish Episcopal Church, was published during last year. The translators have performed their work well, as a general rule. With commendable propriety, advantage was taken of the Gaelic version of the Bible, which is in common use in Scotland, for the purpose of presenting, in a Gaelic dress, those portions of Scripture that, along with the Psalms, go to form a considerable portion of the English Prayer-Book. It is, at least, interesting to know that in Argyllshire itself there are several Episcopal ministers who conduct religious services in Gaelic. It may be safely inferred, that if the bishops of the Scottish Episcopal Church were apprehensive that Gaelic was sadly on the decline, and was hurrying to the day of its death and consequent extinction, they would not have taken the pains of translating the English Prayer-Book into Gaelic.

As might be expected, owing to the great dissimilarity which exists between English and Gaelic idioms, the Gaelic translation of the English Prayer-Book is occasionally stiff. Praise rather than blame, however, is to be generously bestowed on the translators, who have done their work with much ability and accuracy.

In the introduction to his grammar—the first Gaelic grammar which was published—Shaw had this doleful statement to make when it was published in 1778: "But at present I much doubt whether there be four men in Scotland that would spell one page the same way. The taste, at this day, of the clergy—a lettered and respectable order—is to understand the English, content with what Gaelic enables them to translate of a sermon they originally wrote in English. And, although they are obliged to speak in public once in seven days, there are not five ministers in Scotland who write their discourses in their own tongue." Almost one hundred and twenty years have passed since Shaw had occasion to give such a lamentable account of the defective Gaelic scholarship of his time. Immeasurable progress has, in the interval, been made in the grammatical study of the Gaelic language, and in the acquiring of ability and facility to speak and write it fluently and accurately. It would be simply ridiculous to apply the strong condemnation which Shaw attached to the Gaelic scholarship of his own time, to the wide and thorough scholarship which obtains in our day. Were correctness in the understanding and in the writing of Gaelic to be taken as an infallible criterion of the utility of that language, the conclusion could not be resisted, that the chances of a prolonged existence are altogether on the side of Gaelic as we know and speak it now.

"A Course of Gaelic Grammar, by Duncan Reid, F.S.L.A., teacher of Gaelic in the High School of Glasgow:" Such is the writing on the title page of a very useful and intelligible grammar, which was published in August, 1895. The author thus writes in his preface: "In compiling this course of Gaelic grammar, I have adopted the plan which I have followed during the last few years in teaching the students of the Gaelic class in the High School of Glasgow. It is chiefly intended as a text-book for Highland schools and pupil teachers, and is designed to meet the requirements of the Scotch Education Code. The ordinary student will find here sufficient material to enable him to acquire a good knowledge of Gaelic grammar.

The exercises are carefully graded, and the selections for reading, towards the end, are from the standard works of some of the best writers of Gaelic prose and poetry." Though exception may be taken to portions of Reid's Grammar, it has to be admitted that it is very concise and simple, so that the ordinary student can easily obtain a sufficient knowledge of the language, whereby he can be enabled to appreciate its peculiar beauties, and to derive enjoyment from its treasures in prose and verse.

"Elementary Gaelic Grammar or the elements of Gaelic grammar, based on the work of the Rev. Alexander Stewart, D.D., by H. Cameron Gillies." Such is the name of an able and instructive Gaelic Grammar, which was published a few months ago. Dr. Gillies resides in London, England, and is engaged in the practice of medicine. He has for several years devoted much attention to Gaelic. He has a keen critical faculty, insomuch that he finds particular pleasure in prosecuting his studies in the somewhat abstruse domain of Celtic philology. The present position of Gaelic, favourable in a satisfactory degree as it is in London, the metropolis of the world—owes very much to the fine enthusiasm, the diligent learning and the unflinching earnestness of Dr. Gillies. According to his own averment, Dr. Gillies has based his grammar on the work of Dr. Alexander Stewart. It has always to be conceded that Stewart's Grammar, so far as it goes, is the best Gaelic Grammar which has ever been written. Dr. Stewart was minister of Moulin, in Perthshire, when he wrote his grammar, involving as it does—for the field of Gaelic grammar was at that time largely, if not entirely, fallow ground—great acumen and pains and reflection. The splendid Irish scholar, O'Donovan, found abundant reason in the honesty of his heart—able grammarian as he himself was—to bestow warm praise on the ability, industry and acumen of Dr. Stewart. It was Dr. Stewart who corrected the proof-sheets of what is known as "Sinclair's edition of Ossian," which was published in 1807. In the preface to his Grammar, Dr. Gillies thus writes: "The purpose of this Grammar is to afford assistance to such as may desire a living and intelligent acquaintance with the Gaelic language of Scotland. I endeavoured to have special regard to the phonetic basis of the language, and have always appealed to it whenever it was necessary to do so. As Gaelic Grammars are continually making their appearance, it cannot be denied that Gaelic still possesses the pulsations of a healthy and vigorous existence. If a language is dying, and, like the withered leaves of autumn, is showing unmistakable signs of decay and death, no man can have the courage and energy which the writing of the grammar of such a language involves. A decrepit language, an enfeebled and helpless language, a language which is on the brink of the grave, and which is suffering the loss of all its former friends, can by no reasonable possibility induce any man—unless he is enthusiastic to an unwonted degree—to consume the midnight oil in preparing a grammar which, as he honestly thinks, is able to meet the requirements of his own time, and to impart even a moderate amount of life and strength to the language which he loves as the language of his ancestors, and, therefore, of those who are dearest and greatest in his imagination and memory."

The inhabitants of the Isle of Man are conspicuous for their zeal in collecting the literary remains that can be found in their island, whether they assume the form of poetry, or folk-lore, or historical narratives, or carols and ballads. Since the Manx Society was established in 1858, very much has been done to rescue from oblivion many of the literary links that connect the Isle of Man of to-day with the Isle of Man of the days that have gone. At an expenditure of endless energy and trouble, Mr. A. W. Moore, M.A., Cronkhourn, Douglas, has conferred great benefits on the literature of his native island. Through his indefatigable exertions much that will prove to be very valuable in the lore of Manxmen has been recovered and published. In addition to other publications with which he had to do he published, in 1891, "The Carvalyn Gailchagh," or Manx carols. "Manx

Ballads and Music" is the name of another collection which he published toward the end of last year. "The object of this publication," he asserts, "as that of the Manx Carols, is to collect in one volume a curious literature, the greater part of which was threatened with almost certain loss." Though he has been assiduous in collecting those ballads, and in thus preserving from oblivion songs which were wont to be sung by the peasantry of Man, he has no high opinion of the poetical merit of many of them. He divides them into "mythical, semi-historical and historical ballads; children's songs and ballads connected with customs and superstitions; love-songs, patristic ballads, nautical ballads and miscellaneous ballads." He thinks more highly of the Manx melodies than of the ballads, forasmuch as they are in most cases older, as well as superior to the words which are now set to them. He has strong reasons for entertaining the hope "that the results of this little book will be to admit the music of the Isle of Man to a distinct though humble share in the great body of national music which is now being so generally collected," and that in it may be found, in the striking words of a recent writer, "the national idioms in their simplest and most unsophisticated expression." As the music to which ballads are sung intensifies the great regard that the peasantry of any country entertain for their songs, it may naturally be expected that the publication of their songs, along with their appropriate music, will increase the zest wherewith the inhabitants of the Isle of Man sing such songs as "Coayl jeh ny Baatyn-Skeddan," "Mannin veg veen," and "Na Kirree fo Niaghtey."

THE INDIAN CHARACTER. BY E. M. CHADWICK, ESQ.

(Read April 10, 1897).

This paper was read, as views on the same subject had been presented by a reader before the Institute some time previously. Such former paper had not, in the opinion of the present reader, exhausted the subject, nor treated it quite justly or in due proportion, but had rather enlarged upon the faults of the Indians without giving due weight to their better qualities, the reader being impressed with the importance of understanding and recognizing what good there is in those under our care and tutelage, and how many unfortunate mistakes may have been in the past, and possibly may be in the future, avoided by a better knowledge of what the Indian has been, is, and may be.

The Indian, as a subject of which so many have written, has been in this respect at a great disadvantage, and has been treated with much injustice, because, firstly, his history has, for the most part, been written by his enemies; secondly, most writers have formed their impressions from tribes which have been deteriorated from contact with unscrupulous whites, diminished by intemperance and the diseases which have ever marked the advance of civilization, impoverished by the destruction of their accustomed means of subsistence, and disheartened and dispirited by the change in their circumstances; and lastly, because it has been a common practice to gauge the Indian by a European standard. This last, however, may be regarded as an unintentional but very marked tribute to the innate merits of the Indian, for other uncivilized people have been described either without reference to other conditions than those in which the writers happened to find them, or by comparison with people of similar circumstances.

The reader reviewed the various traits of the Indian character at length, and concluded as follows:

While the policy of our Government has ever been wise and commendable, and has been generally honestly carried out by the executive agents and officers, I cannot but think that in one respect a grave mistake has been commonly made by those charged with duties bringing them into immediate contact with the Indians, both officials and others, and perhaps especially missionaries, whose methods are apt to be unduly patronizing. The Indian is in many respects child-like, knowing that the white man's knowledge is superior to his, and, therefore, when his tutelage begins he enters into a relation as regards the whites similar to that of pupil and teacher. This condition is one of much difficulty, requiring management with a tact and skill such as few people are able to exercise. If the Indian were treated as a friend and equal rather than as a pupil or dependent, I believe his advancement would be more certain and speedy. Individual cases of Indians revolting, and perhaps with little or no apparent reason, from the guidance or control of agents or missionaries will no doubt occur in the experience of such people, without their perceiving that a certain amount of fault may lie with themselves. I do not wish to be understood as unduly criticizing either agent or missionary, for in Canada I am convinced that our Indian agents as a class are men competent and well worthy of the great trust and responsibility imposed upon them, as I certainly know some of them to be; and for the missionaries I have the highest respect, believing that upon the faithful performance of their

duties, more than anything else, depends the future welfare of the Indian as a civilized citizen. But even missionaries are human, and sometimes make mistakes, and they have many serious difficulties to contend with, for not only have they to overcome such as necessarily arise from the character of the Indians, and customs and circumstances of their former life, but they have also to fight the devil incarnate in the persons of evil and unscrupulous whites, who, for their own gain or gratification, do not hesitate to bring moral and physical ruin upon the Indian.

It is to me a matter of much regret that in the process of bringing the Indian into civilization there has been an effort to make him forget his past history and customs. Much of the history of some, at least, of the Indian nations is by no means a thing to be wiped out of memory, and, though some of their customs must necessarily be disused, as being inconsistent with both Christianity and civilization, the romantic and picturesque, which ever attended the life of the Indians, and surrounded them with a charm which has produced abundant material for writers of fiction and poetry, is surely worth preservation, and, in my judgment, should be no more a hindrance to their advancement than somewhat similar conditions have been in the case of the Highlanders of Scotland. I am convinced that an Indian who holds the memory of his forefathers in respect, and looks back with honest pride upon the antiquities of his nation, and is permitted to do so, will make a better citizen than one who is taught, as is evidently too often the case, to consider all such things as contemptible, and to be put aside and buried in the past. Among the Six Nations, those who are disposed to keep alive their traditions and such of their ancient customs as are not unsuited to their present manner of life, are subjected to a kind of mild social ostracism. I venture to believe that to be a great mistake, and for my part would regard an Indian who had the courage to appear in buckskin and feathers, without being paid for doing so, as excellent material from which a valuable citizen might be made if judiciously treated. The system which is followed, I believe, with all due deference to those who have more experience than I have, to be calculated to make such men and women useless members of society, and thus indirectly to lower the general social and moral tone of the people. A loyalist at heart, if injudiciously treated, may be made a rebel in act.

INDIAN GHOSTS AND CONCH FEASTS. BY R. G. HALIBURTON, F.R.G.S., ETC.

(Read April 10, 1897).

Had the natives of Jamaica any connection with the races of North or South America? This is a question which we cannot discuss in the limited state of our knowledge of West Indian natives. This arises partly from the fact that the cruel power that is now deluging Cuba with blood, succeeded in little more than a century in exterminating the friendly and peaceable natives of the West Indies.

No page in the history of our race presents such a blank as that which refers to those people. The Spaniards said that the natives reminded them of the people of Majorca; but that race was a small one, and no doubt an offshoot of the dwarf stock that, according to Professor Sergi, migrated from North Africa to the islands, and to the Northern shores of the Mediterranean. The Spaniards probably referred to the little Caribs. In the Atlas region of Morocco the dwarfs and their large offshoots are called "the little Haritin" and "the large Haritin." When I first, in 1890, saw one of the latter, I said "that man must be a Carib." The dwarfs range from 4 feet to 4 feet 10. Their larger kinsmen are from 4 feet 10 to 5 feet 4 inches, and both have that peculiar, bright-reddish complexion, that so generally characterizes dwarfs. My Berber servant (thanks to whom I became their discoverer) said, "they have a red complexion, quite different from that of other races in Morocco. It is like that of the red Indians of America." A recent color chart by a German anthropologist makes the Tupi Guarani and most other races of South America have the same tint as the Berbers. The fact that their names for spirits, or ghosts, *Cemis*, and *Tona*, are to be met with in Central America, and as far north as the Pueblos, leads us to suspect that the people of the islands, and of Central America must have sprung from the same stock.

Brasseur de Bourbourg's idea that the Popul Vuh was historical, even though he was backed up in it by Max Muller, he had to abandon in his old age. It was a mythical work, containing astronomical legends that are as wide-spread as the wanderings of our race. Within the past two years cave deposits and inscriptions have been found in Yucatan, that lead to the idea, that the Mayas, when they arrived there, were already a semi-civilized people.

We must be patient, and must collect in properly managed museums all that can be gathered together as to the aborigines of the West Indies. In time this great blank in anthropology will be filled up, but we now have tantalizing glimpses of affinities, that serve only to stimulate and baffle our curiosity.

Bishop Hanna was right in his conjecture, that aboriginal remains would probably be found, if sought for, in Pedro, Jamaica. The contents of the caves there are well-known, although it is possible that treasure-seekers, or even antiquaries, may a century or two ago have carried away or destroyed much in them that would have been of interest. On the top of a hill at Malvern Chase, it was said, when I was there eleven years ago, that there was an Indian burial place. I employed a couple of men for one or two days in opening some places that seemed promising, but the results were on the whole disappointing. On digging down in some places there, we found an almost solid mass of little shells, about two inches thick, in a regular layer. But we found no skeletons or human bones, although we came across a large quantity of broken pottery, which seemed to have been an offering to the

dead, for when an article is broken, it belongs to the spirits. On Haugmena night, New Year's Eve (for "Haug" means a "ghost," and the spirits then pay the earth a visit, as they do also at Hallow-eve, and the Eve of May-Day), it is a custom among Highlanders to drink a toast, and then to throw the wine-glasses over the left shoulder, no doubt once a mode of making an offering to ancestral ghosts. The Maori used to always offer a grace to ancestors by throwing a little food over the left shoulder. On spilling salt, many people, to avert ill-luck, throw salt over the left shoulder. All this dates back to an era when our ancestors were somewhat like the old aborigines at Pedro.

The ashes and a few bones were quite consistent with funeral, or memorial feasts. There were indications that the place had been opened before, and it is possible that skeletons may have been carried away.

The pottery we found was of singular interest. There were some dishes about six inches long, very shallow and graceful in shape, with handles formed of frogs' heads most artistically executed. I have not seen anything of the sort to equal them in the Peabody Museum collection from Central America.

The frog was the symbol of rain and of the rain-god in Mexico and in Central America. The pottery was evidently intended to be hung up, as it was pierced, or had handles for that purpose, like Guanche pottery. The gypsies, who, like the Berber tribes on the coast opposite the Canaries, hang up their drinking cups, believe that if they are allowed to touch the ground they are thereby consecrated to the dead, and must be broken in pieces.

Before I dismiss the subject of destroying articles as a mode of offering them to spirits, I may mention a singular custom of the Spanish gypsies, who at a certain feast collect many bushels of confections made (if I remember right) of white powdered sugar. These are thrown on the floor of the dancing room, until it is covered with a layer two or three inches deep. Of course the cost of this proceeding is a very heavy one. The Gypsies then, men and women, commence a weird, frenzied dance, in which they work themselves up into a delirium and then sink down exhausted. The sugar clogs their feet, and covers their legs and garments, and when they cease dancing, they present a most singular and sorry picture.

Though archaeologists cannot conjecture the origin of this custom, we may form a shrewd guess as to what this dance means. The ghosts are in for a big candy frolic, and the sweetmeats must be destroyed before the spirits can own them. The rationale of these ideas is, I think, capable of a very simple explanation. With primitive races of men everything in nature has its spiritual double. The soul of the hunter's dog goes to the Land of the Blessed and hunts game there for his master, just as he did on earth; and the warrior fights, loves, and feasts as heartily as he did when in the flesh. (1)

In the Peabody Museum of Anthropology there is to be seen half a bushel of pearls, some of large size, that have been subjected to the action of fire. They have not been destroyed; they have only been translated to the necks and arms of tawny warriors. Who knows that the only pale-faced ghost, that of the late George Washington, that ever found its way into the Red Man's Paradise, may not have often seen and admired them?

All this serves to explain the meaning of the Mysteries, or initiations of prehistoric man, and of antiquity. With Christians admission to the society of the blessed must be obtained through the atonement. With primitive man this was

(1) Maspero in "The Struggle of the Nations," a translation of which has just been published by Appleton & Co. (N. Y., 1897), since the above paper was read, says (p. 523) of the mummies of pets of the deceased placed in Egyptian tombs, "A few of the principal objects were broken or damaged, in the belief that by thus destroying them their double would go forth and accompany the human double, and render him their accustomed service during the whole of his posthumous existence."

This is a singular confirmation of my conjecture, and shows how much of prehistoric man survived in the Egyptian.

accomplished by initiation. To become a blessed spirit, a man must die. Hence "the death of the Mysteries," or "Cabeiric death," which was brought about by exhausting ordeals, long fastings, and the use of narcotics, under the effect of which the aspirant lost consciousness, and fell into a death-like trance. He was then buried and resurrected, but he returned a blessed spirit. An American Indian who has been initiated indulges in the boast, "I am a spirit." Death thenceforth has no spiritual terrors for him (2).

This was the Egyptian belief. The deceased worshipper of Osiris, who had been initiated into "the Mysteries of Isis," himself became an Osiris, and, as a "Blessed Osirian," reigned with the gods. These ideas can be detected in the Apocalypse, a work permeated by the astronomical imagery, the symbolism of numbers, and the allegorical spirit of the venerable Mysteries. Read by the light of primitive cults, the following significant passage becomes a little more intelligible than it has hitherto seemed.

"Blessed and holy is he that hath part in the *first resurrection*; on such the *second death* hath no power, but they shall be priests of God and of Christ, and shall reign with Him a thousand years" (Rev. 20:6).

In 1888 I mentioned to Professor Maspero verbally, and afterwards by letter, that the "*Osirian cult*" still existed in America. *Osiris* is the Greek form of *Hoesari* in Egyptian, which in Phoenician and in the traditions of southern Morocco and the western Soudan is *Isiri*. Among the Caribs and the Abipones of South America the name is *Hoscheiri*, or *Ischeiri*, and the initiated becomes an Ischeiri after death.

I shall hereafter bring out these points in a paper on "Vestiges of the Osirian Cult in the New World."

Shell mounds are to be found from the icy North to the Straits of Magellan. At a suitable time of the year the Indians used to pic-nic for weeks on the seashore. In New England they bequeathed their indigestible but tempting "clambake" to the Pilgrim Fathers and their descendants; and their memory will be preserved green as long as "clam-chowder" endures.

On the shores of the Gulf of Mexico, where oysters took the place of the venerated clam, there are many "shell-islands" where there are enormous deposits of oyster shells. I spent the winter of 1882-3 on one called Tiger-tail Island, where that terrible Seminole Chief, Tiger-tail, was wont to roast and bake oysters, in place of Yankees.

In the Caribbean Sea the conch took the place of the oyster. I chartered a schooner in 1870 and explored the network of little islands and inlets in the British and Foreign Leeward and Virgin Islands, which no one ever visits. As Pere Labat speaks of heaps of shells left by the Caribs at Anegada, I thought I would take a look at them. The island is surrounded by a network of coral reefs extending ten miles to the seaward, and but few strangers reach it except those that have been washed ashore. I found the people there (about two hundred in number I should think), much disturbed by my visit, and they refused at first to come with me. But the next morning the whole population seemed to turn out to aid me. I afterwards learned that on my arrival they had held a meeting, at which it was resolved that, as no man in his senses would think of opening a heap of old conch

(2) The following passage, from Mr. Lyman Abbott's article in the Outlook (Mar. 1897), is applicable to the belief of prehistoric man: "What is God's way of doing things according to evolution? It is to develop life by successive processes, until a spirit akin to this appears in a bodily organism, akin to that of the lower animals from which it had been previously evolved. This bodily organism is from birth in a constant state of decay and repair. At length the time comes when, through disease or old age, the repair no longer keeps pace with the decay. Then the body returns to the earth, and the spirit to God who gave it. . . . But every death is a resurrection of the spirit. What we call death, the New Testament calls 'an exodus,' or an emancipation from bondage, an 'unmooring,' or setting the ship free from its imprisonment. The spirit is released from its confinement, and the release is death. Death is, in short, not a cessation of existence, not a break in existence: it is simply what Socrates declared it to be, 'the separation of the soul and body; and being dead is the attainment of this. When the soul exists in itself, and is parted from the body, and the body is parted from the soul, that is death.' (See *Phædo*, Jowett's Trans.)"

shells, I must be in search of Captain Kydd's treasure. They then generously resolved that I be permitted to open these mounds, but at my own expense ; and they further resolved, that while they would help me to find the treasure, they would never allow me to carry off a penny. Anxious to have a hand in the "find," they flew upon the shell mounds like demons ; but I did not wish to pay all the people of the island, and therefore selected three or four, who opened half a dozen shell mounds, watched with intense anxiety by the rest of the people. We found only shells and ashes, nothing of interest, and, sad to say, no vestige of Captain Kydd and his hoards.

I encouraged that idea about Captain Kydd by looking very mysterious, consulting my notebook, pacing off the distance between certain objects, and behaving generally like a truant land-surveyor. My benevolent object was, I subsequently learned, most fully accomplished, for the people there are now the highest living authorities on the subject of Carib shell mounds. For a fortnight after I left, the whole population turned out, and overhauled all the numerous shell mounds in the island ; but, unfortunately, they found nothing. They then concluded that I had inherited some invaluable notebooks and maps from my worthy ancestor, Captain Kydd, and that I had slipped ashore in the night, and had carried off millions of "pieces of eight" and "Spanish Joes."

A friend, Chief Justice Semper of St. Kitts, warned me never to venture near that island again, and I have taken his advice. It was the cheapest bit of archaeological exploration on record.

This fish diet must have greatly contributed to the vitality and vigor of the Indians. The prevalent idea that fish is so little nutritious that, to dine on fish is equivalent to fasting, was a little shaken by the fact, that communities that live on fish are very prolific. A gentleman, whom I met recently at the Toronto Club, and who had spent some winters at Hudson's Bay, told me that it was a favorite amusement there to pit the fish-eating against the flesh-eating Indians in trials of strength, and that in every case the former came off victorious.

NOTE ON SOME BASIC DYKE AND VOLCANIC ROCKS OF EASTERN ONTARIO
AND QUEBEC. BY W. G. MILLER, M.A.

(Read April 18, 1897).

Dr. F. D. Adams, in his recently published "Report on the Geology of a Portion of the Laurentian Area Lying to the North of the Island of Montreal" (1), describes a series of post-archæan dykes which are stated to be "probably pre-Potsdam in age." The rocks in these dykes are of three different kinds, viz.: diabase, augite porphyrite (spilite type), and a rock which "is neither a diabase nor a gabbro, having neither the ophitic structure of the former nor the hypodiamorphic granular structure of the latter. The structure is rather a porphyritic one . . ."

It may be interesting to note that a similar series of basic rocks occurring in dykes is characteristic of the Kingston district, which is distant about 150 miles from the area referred to by Dr. Adams.

In a paper (2), published some time ago, Mr. R. W. Brock and the present writer described two rocks which with diabase are the characteristic basic dyke and volcanic rocks of the eastern part of Frontenac county and the adjacent portions of the counties of Leeds and Lanark. One set of dykes, which occurs near the village of Seeley's Bay is, judging from Dr. Adams' description, practically identical in character with those he has described in the district north of Montreal, and which he calls augite porphyrite (spilite type).

The rock referred to by Dr. Adams as being "neither a diabase nor a gabbro" is represented in the Kingston district by a rock which resembles it closely. The Quebec rock is apparently somewhat more basic than its Kingston representative, and contains phenocrysts of both augite and plagioclase, of which the former is the older. Unless, however, a series of analyses were made of specimens selected from different parts of the dykes, it would not be possible to make a satisfactory comparison of the acidity of the dykes in the two districts. One of the striking characteristics of these rocks from both districts is the occurrence in them of micropegmatite or a granophyric intergrowth of quartz and feldspar. Dr. Adams says, "This micropegmatitic or granophyric intergrowth of quartz and feldspar will probably be found very widespread in its occurrence in the dykes cutting the archæan in Canada, as it is known in diabases of Templeton, in the County of Ottawa, in the Province of Quebec, while Dr. Lawson describes it as occurring abundantly in the dykes of the Rainy Lake district to the west of Lake Superior."

Prof. C. H. Smyth has described a group of diabase dykes among the Thousand Islands, St. Lawrence River, in the southern part of the County of Leeds (3). These also have representatives in the area described by Dr. Adams.

Different varieties of plutonic rocks related to gabbro are found in the two districts. Letting the term gabbro stand for these, norite and anorthosite, we have an interesting series of rocks in the two districts, including—if we consider the rock containing micropegmatite to belong to the dyke division proper—plutonic, dyke

(1) Pp. 134 to 139. Part J. Annual Report, Vol. VIII., Geol. Survey of Canada.

(2) Canadian Record of Science, October, 1895.

(3) Transactions N.Y. Academy of Sciences, Vol. XIII.

and volcanic representatives of the gabbro group. Their relations may be shown in tabular form as follows:

Gabbro Group.	{	Plutonic.....	Gabbro.
	{	Dyke	Gabbro porphyrite.
	{	Volcanic.....	{ Diabase. Augite porphyrite.

Whether the rock here placed under the dyke division be considered to belong there or under the volcanic division we have an interesting series which includes the characteristic pre-Potsdam basic rocks of the two districts. Representatives of other sub-divisions of the gabbro dyke rocks, viz.: gabbro aplite (or beerbachite) and gabbro lamprophyre (or odinite) have not as yet been found in the districts under consideration.

THE VAPOR TENSIONS OF LIQUID MIXTURES. BY W. LASH MILLER, PH.D.,
AND T. R. ROSEBRUGH, M.A.

(Read April 24, 1897).

Much of the recent remarkable progress in physico-chemical work is due to experimental and theoretical investigations on the vapor tensions of solutions, and Professor Van 't Hoff's paper showing the relations between the tensions, freezing-points, boiling-points, osmotic pressures and compositions of solutions marks a new epoch in the science. In his celebrated monograph "On equilibrium in heterogeneous systems" Prof. Willard Gibbs has deduced an equation (1) from which may be obtained a relation between the alterations produced in the vapor tensions of the components of a liquid mixture by altering the composition of the mixture. A close examination of this result of Gibbs' and of the method by which it was obtained, shows that his equation contains as special cases many of the results of Van 't Hoff referred to above; it is consequently very desirable to subject the equation in its most general form to a direct comparison with experimental results. Such a control would be afforded by a set of measurements of the tensions and compositions of the vapors given off at any constant temperature by mixtures of two liquids in different proportions, but curiously enough no complete set of measurements of the nature referred to seems as yet to have been published. We have undertaken to supply the requisite data by an investigation of the case of mixtures of alcohol and water; the present paper contains a short description of the apparatus employed, the results of the measurements, and their comparison with the theory will form the subject of a subsequent communication.

The apparatus, as finally constructed, consists of a cylindrical vessel to hold five litres, made of tinned copper, and provided with five openings. Of these, the first is fitted with a thermometer, the second with a means of filling and emptying the vessel, the third with means of electrical communication to a heating coil suspended in the liquid; while through the fourth passes a glass tube to convey the vapors to a condenser, from which the condensed liquid drops back through the fifth opening into the apparatus. When desired, small quantities of the condensed vapor may be removed and their composition ascertained; these analyses, together with a knowledge of the composition of the contents of the copper vessel and measurements of the temperature and pressure, give all the data necessary for testing the accuracy of the equation of Gibbs referred to above.

In order to protect the vapor from partial condensation (and consequent fractionation) on the way to the condenser, the tube through which it passes is wound with insulated wire and may thus be kept hot electrically; errors due to splashing of the boiling liquid have been provided against by a special construction at the bottom of the tube; condensation on the walls of the copper vessel itself is prevented by surrounding the latter with a tin cylinder wound with wire and kept at the temperature desired by means of an adjustable electrical current, while the absence of super-heating, and a thorough equilibrium between vapor and liquid, are secured by the use of perforated copper plates (under the surface of the liquid) through which the vapor must find its way.

(1) Trans. Connec. Acad. III. 143. Egn. No. 97.

As it is desirable that the boiling points of the mixtures should be varied at pleasure, a subsidiary piece of apparatus has been constructed by means of which the pressure in the boiling vessel may be maintained constant at any desired point from 20—1200 mm. This pressure-regulator consists of two five-gallon jars, of which the first is attached directly to an air pump, and the second to a U-tube manometer and to the boiling apparatus (between condenser and fifth opening); communication between the jars is afforded through a tap, which is usually closed, but may be opened by an electrical device set in motion whenever the mercury of the manometer (in the open limb) rises high enough to form contact with an adjustable platinum wire.

NEW SPECIES OF CANADIAN FUNGI. BY J. B. ELLIS AND J. DEARNESS.

(Read April 24, 1897.)

HYMENOMYCETES.

PORIA SUBRUF A, E. & D.

Resupinate, effused, mostly in small patches 2—4 cm across, inseparable, soft, juicy, creamy-white when fresh, becoming reddish when dry; margin thin, membranaceous, narrow, almost wanting. Pores round to sub-angular, $\frac{1}{4}$ — $\frac{1}{2}$ cm. long, $\frac{1}{4}$ — $\frac{1}{2}$ mm. wide, dissepiments thin, margin acute but not lacerate. Spores elliptic-oblong $4 \times 3 \mu$.

On a rotten beech log at Granton, Ont. Nov. 1896. No. 2442 in Herbarium of J. Dearness.

Apparently allied to *Poria cruentata*, Mont., but the pores cannot be called "very short," and their surface is uneven.

PYRENOMYCETES.

ROSELLINIA COMPRESSA, E. & D.

Perithecia scattered or often in small groups of 4—6 or more, sometimes 2 or 3 sub-confluent, superficial, rather depressed, globose, about $\frac{1}{2}$ mm. in diam., membranaceous, sparingly clothed with short (20—30 μ) spine-like, black hairs; ostiolum minute, papilliform. Asci cylindrical, 75×10 — 11μ , obscurely paraphysate. Sporidia uniseriate, elliptical, obtuse, brown, strongly compressed, 12 — 16×8 — 10μ and about 3μ thick,

On decorticated elm, Granton, Ont., Canada. Herb. D., No. 1791.

DIDYMOSPHERIA THALICTRI, E. & D.

Perithecia gregarious, depressed-globose, 200 to 250 μ in diam., visible through the darkened epidermis which is barely pierced by the papilliform deciduous ostiolum. Asci oblong, short stipitate, paraphysate, 8 spored. Sporidia biseriate, at first fusoid-oblong, sub-hyaline, 4-nucleate, but finally uniseptate and slightly constricted, sub-inequilateral or slightly curved, pale brown, 13 — $15 \times 3\frac{1}{2} \mu$.

On dead stems of *Thalictrum polygamum*, London, Can., Aug. 1895. Herb. D., No. 2297.

DISCOMYCETES.

PSEUDOHLOTIUM CANADENSE, E. & D.

Ascomata scattered, short-stipitate, whitish, with a yellowish tinge, about 1 mm. in diam., puberulent; margin fringed with tufts of short, pale hairs, and when dry the opposite sides rolled together so as to become elliptical or triangular in outline; texture, fibrous; apparently sessile, but short-stiped. Disk concave, yellowish. Asci, clavate-cylindrical, paraphysate, about $40 \times 4 \mu$. Sporidia biseriate, oblong, obtuse, mostly straight, hyaline, 8 — $12 \times 1\frac{1}{2}$ — 2μ .

On dead stems of *Arctium Lappa* L., London, Can., Aug., 1895. Herb. D., No. 2340

COCCOMYCES RUBICOLA, E. & D.

Ascomata covered by the adnate epidermis, hemispheric-prominent; the pustules pierced in the centre, then radiate-cleft and open, exposing the pale, whitish or wood-coloured disk, $\frac{1}{2}$ —1 mm. in diam., bordered by the toothed margin of the ruptured ascoma. Asci, oblong-cylindrical, sessile, 60—70 x 7 μ . Paraphyses, filiform, curved or bent at the tips. Sporidia fasciculate, linear, nucleate, hyaline, sub-attenuated below, 45—60 x 2—2 $\frac{1}{2}$ μ .

On dead stems of *Rubus strigosus*, Granton, Ont., Aug., 1895. Herb. D., No. 2352.

C. Rubi (Fr.) is a follicolous species, having sporidia only 6—8 μ . long.

HYPHOMYCETES.

RHINOTRICHUM HERBICOLUM, E. & D.

Effused, light yellow, becoming brown in the centre. Hyphæ, coarse, septate, branched, nearly hyaline, 8—10 μ , thick. Fertile hyphæ, sub-undulate above, tips swollen and bearing the globose, sub-hyaline, finely echinulate, 7—9 μ , conidia.

On dead stems of *Solidago Canadensis*, London, Can., Aug. 1895. Herb. D., No. 2314.

This species differs from *R. Curtisii*, Berk., in its coarser hyphæ and its smaller echinulate conidia.

STYSANUS TUBERICOLA, E. & D.

Stem composed of parallel fibres, 700 to 800 μ high, 10—12 μ thick, tips of the fibres relaxed and bearing the elliptical, brownish, 4—5 x 2 $\frac{1}{2}$ —3 μ conidia, forming a terminal oblong head 110—130 x 35—50 μ . The fibres forming the stem spread out at the base forming a loosely interwoven grayish mycelium.

This fungus developed on pieces of potato in a moist chamber which had been used for culture purposes. Other pieces of potato were inoculated with it and thus a considerable quantity was obtained. London, Can., Apr. to June, 1894. Herb. D., No. 2261.

RAMULARIA ARISÆMÆ, E. & D.

Spots oval, tan coloured, turning pale or yellow-white by concentric rings from the centre outwardly, $\frac{1}{2}$ to 2 cm. Conidial tufts minute, very numerous, mostly epiphyllous, giving a grayish cast to the pallid area of the leaf, the tuft consisting of a few close, almost sessile, conidia. Conidia hyaline, grumous, nucleate, straight, 20—22 x 3—3 $\frac{1}{2}$ μ .

On leaves of *Arisæma triphyllum*, Torr., Granton, Ont., July 1893. Herb. D., No. 2139.

TORULA CARICINA, E. & D.

Hypophyllous forming dense dark olive, orbicular or elliptical patches, 1—2 mm. diam., composed of erect, simple or branched from the base, chains of closely connected, smooth, translucent, pale brown conidia, 20—30 μ long, consisting of 10 to 15 conidia about 3 μ in diameter.

On dead leaves of *Carex lupulinus* var.—; London, Can., Sept. 1896. Herb. D., No. 2403.

T. graminis, Desm., also occurring on species of *Carex*, has conidia 5 to 6 μ in diam., becoming black.

CLADOSPORIUM (?) MYRIOSPORUM, E. & D.

The fungus first appears as pale specks on the pea-pod; it soon becomes erumpent in small, light-coloured tufts, and finally confluent, forming a scurfy or faveolate scabby coat on the pod. From the first the much-branched, fertile hyphæ produce

abundantly minute hyaline conidia, little over $1\ \mu$ long, but as the tuft develops the branches darken and the spores become larger, darker, and some of them septate. Their shape is mostly oblong, slightly pointed at one end, truncate at the other, showing the circle of attachment. Continuous spores vary from $1\frac{1}{2} \times 1$ to $14 \times 4\ \mu$, septate ones from 10×3 to $30 \times 6-8\ \mu$. Under a high power all except the smallest are seen to be rough or minutely echinulate. The hyphæ are sub-fasciculate, simple or septate, sub-geniculate, varying in colour from hyaline to olivaceous, sub-dentate or entire above, $40-80 \times 3-6\ \mu$.

On pea-pods, communicated by Dr. J. Fletcher, Ottawa, from South Vancouver, B.C., and by B. C. Buffum, Laramie, Wyoming. Aug. 1896. Herb. D., No. 2395.

This fungus was so injurious in the British Columbia locality that the crop was not threshed.

CLADOSPORIUM ACUTUM, E. & D.

Black tufts, $\frac{1}{4}-1$ mm. diam., thickly scattered over the lower surface of the leaf, sparingly confluent. Fertile hyphæ cæspitose, olive brown, nearly straight, 3-5 septate, $80-110 \times 3\frac{1}{2}-4\ \mu$, abruptly and mostly obliquely pointed at the apex. Conidia elliptic, 1-septate, becoming brownish, $10-15 \times 6-8\ \mu$.

On fallen ash leaves, London, Can., Oct. 1896. Herb. D., No. 2441.

CERCOSPORA CARICINA, E. & D.

Tufts punctiform, minute, seriate between the parallel ribs of the leaf. Hyphæ cæspitose, mostly continuous, brown, notched and crooked above, 15 to 25×3 to $3\frac{1}{2}\ \mu$. Conidia slender, obclavate-cylindrical, hyaline, continuous, $34-73$ (mostly $35-50$) $\times 3\ \mu$.

The leaves of the host are at first dotted with brown specks and blackened, finally becoming dead and then lighter in colour.

On leaves of *Carex rosea*, London, Can., Aug. 1896. Herb. D., No. 2390.

CERCOSPORA LESPEDZÆ, E. & D.

Spots irregular, red, bounded by the veinlets, 2 to 5 mm. Tufts of conidia epiphyllous, hyphæ continuous, pale brown, $10-25 \times 4\ \mu$. Conidia clavate-cylindrical, $35-50 \times 4\frac{1}{2}\ \mu$, 1-5-septate.

On leaves of *Lespedeza capitata*, Michx., London, Can., July, 1893. Herb. D., No. 2135; N.A.F., No. 3094.

SPHÆROPSIDÆ.

PHYLLOSTICTA HERACLEI, E. & D.

Spots large, 1-2 cm., reddish brown, indefinite, finally confluent and covering a large part of the leaf, which becomes pale and dry. The spots at first are margined with a faint yellowish zone. Perithecia mostly epiphyllous, nearly black, sub-erumpent, $110-125\ \mu$. Spores hyaline, oblong, continuous, $3\frac{1}{2} \times 1\frac{1}{2}\ \mu$.

On leaves of *Heracleum lanatum*, Michx., London, Can., September, 1892. Herb. D., No. 2026.

PHYLLOSTICTA HISPIDA, E. & D.

Perithecia gregarious, innate, globose, with a broad round opening, small ($75-80\ \mu$) visible on both sides of the leaf, but more distinct and prominent below. The leaf is clouded with dark, indefinite patches, but there are no distinct spots. Sporules oblong-cylindrical, obtuse, $3-4 \times 1\frac{1}{2}\ \mu$.

On leaves of *Smilax hispida*, Muhl., London, Can., Sept.-Oct., 1896. Herb. D., No. 2424.

PHOMA PANICULATA, E. & D.

Perithecia scattered, convex, hemispherical, about $\frac{3}{4}$ mm. in diam., covered by the epidermis which is raised into little black blisters and finally irregularly ruptured.

Sporules oblong, 20—30 x 8—10 μ , rounded at the ends, hyaline, filled with granular matter.

On dead limbs of *Cornus paniculata*, London, Canada, May, 1893. Herb. D., No. 2099.

This differs from *Phoma Corni*, Fckl., and *P. Corni Sueciae* (Fr.), in its much larger sporules.

DENDROPHOMA POARUM, E. & D.

Perithecia erumpent superficial, papillate, hemispheric to conical, 150 to 200 μ in diam. Sporules oblong-fusoid, hyaline, with a small nucleus in each end, 10—12 x 2—2½ μ , terminal and lateral on dichotomously branched basidia, 20 x 1½ μ .

On culms and inflorescence of *Poa annua*, London, Can., June, 1894. Herb. D., No. 2266.

VERMICULARIA SAMBUCINA, E. & D.

Perithecia gregarious, numerous, erumpent, hemispheric-depressed, 90—180 μ , thickly beset with dark dark-brown, short bristles 40—100 μ , mostly about 45 μ . Sporules hyaline arcuate-fusoid, nucleolate, 24 x 3—3½ μ .

On dead young stems of *Sambucus* sp., London, Can., Aug., 1895. Herb. D., No. 2310.

DIPLODIA THALICTRI, E. & D.

Perithecia sub-gregarious, sub-cuticular, depressed-spherical or elliptical, small, 150—200 μ , visible through the thin epidermis which is raised into pustules and pierced by the papilliform, soon deciduous ostiola. Spores oblong-cylindrical, obtuse, 1-septate, pale brown, not constricted, 8—10 x 3½ μ .

On dead stems of *Thalictrum polygamum*, London, Can. Herb. D., Nos. 2211 and 2296.

ASCHOCHYTA LEONURI, E. & D.

Spots 1—1½ mm., numerous, thin, appearing as if the tissue were eaten out by a minute leaf-miner; round or angular, small, becoming confluent and then causing the part of the leaf to drop out. Perithecia 150—170 μ , visible from both sides of the leaf. Sporules oblong-cylindrical, uniseptate, pale, 14—17 x 3½—4 μ .

Perithecia larger and spores different, otherwise like *Phyllosticta decidua*, E. & K.

On leaves of *Leonurus cardiaca*, L., London, Can., July, 1893. Herb. D., No. 2160.

HENDERSONIA DISCOSIODES, E. & D.

Spots deep red-brown, definite, sub-orbicular or irregular in shape, 2—10 mm. in diam. Perithecia epiphyllous, discoid, about ½ mm. diam., bordered by the ruptured epidermis, black. Sporules oblong or clavate-oblong, 3-septate and slightly constricted at the septa, smoky-hyaline, 14—16 x 4—5 μ , on slender pedicels about as long as the sporules. The spots finally become whitish in the centre.

On leaves of *Crataegus* sp. London, Can., Aug. 1893. Herb. D., No. 2186.

H. foliorum, Fckl., has curved, darker sporules than this species.

HENDERSONIA OSTRYIGENA, E. & D.

Perithecia scattered, about ½ mm. in diam., buried in the bark which is blackened over them and raised into pustules pierced by the minute ostiola. Sporules oblong, 3-septate, not constricted, brown, obtuse, 10—12 x 4 μ , exceptionally with one cell divided by a longitudinal septum.

On dead limbs of *Ostrya Virginica*, London, Can., May, 1893. Herb. D., No. 2170.

CAMAROSPORUM ULMI, E. & D.

Perithecia gregarious, subglobose, about ½ mm. in diam., soft, slate-colour inside,

buried in the bark, their minute punctiform ostiola piercing but scarcely raising the epidermis. Sporules ovate, 3-septate, sub-muriform, brown, $12-13 \times 6-8 \mu$.

On dead branches of *Ulmus* sp., London, Can. Herb. D., No. 2286.

ASCHERSONIA CARPINICOLA, E. & D.

Stromata convex, erumpent, about 2 mm. in diam., seated on the inner bark, loosely embraced by the lobes of the ruptured epidermis, of carnose texture, nearly amber color when fresh, darker and sub-rufous when dry, easily deciduous. Perithecia minute, buried in the stroma with their dark-colored papilliform ostiola erumpent. Sporules elliptical, hyaline, $15-20 \times 6-8 \mu$ on short basidia.

On bark of dead *Carpinus Americana*. London and Dorchester, Ont. Herb. D., No. 2173.

SEPTORIA HYDROPHYLLI, E. & D.

Spots brown, at first 2-4 mm., circular, at last angular; smoky beneath. Perithecia epiphyllous, numerous, $50-80 \mu$. Sporules straight or curved, hyaline, $35-45 \times 1\frac{1}{2} \mu$.

On leaves of *Hydrophyllum Virginicum* L., London, Can., May, 1893. Herb. D., No. 2130.

SEPTORIA HELIOPSISIDIS, E. & D.

Spots irregular, beginning reddish brown, becoming darker, numerous, 2 to 5 mm. in diam. The part of the spot in which the perithecia develop becomes pallid so that the brownish spots become mottled with white areas. Perithecia amphiphyllous, on small whitish areas, sunken, dark-brown, $85-100 \mu$. Sporules, straight or flexuous, $23-54 \mu$, mostly $40 \times 1 \mu$.

On leaves of *Heliopsis laevis* Pers., Thamesville, Ont., Aug. 1892. Herb. D., No. 1981.

PIGGOTIA NEGUNDINIS, E. & D.

On leaves of *Negundo aceroides*. Perithecia minute, subglobose or subelliptical, $50-70 \mu$ diameter, connate in minute, flattened, punctiform tubercles thickly scattered over the lower surface of the leaf, and at first covered by the epidermis, but soon exposed. Sporules oblong, hyaline, continuous, $2\frac{1}{2}-3 \times 1 \mu$.

Differs from *P. Fraxini* B. & C. in its smaller sporules.

On living leaves of *Negundo aceroides*, London, Can., Sept., 1896. Herb. D., No. 2402.

MELANCONIEÆ.

GLOEOSPORIUM CARPINICOLUM, E. & D.

Spots sub-orbicular, definite, dark brown, 2-5 mm. in diam. Acervuli innate, numerous, minute. Conidia minute, $3-4 \times 1\frac{1}{2}-2 \mu$, issuing on both sides of the leaf in snow-white tendrils.

On leaves of *Carpinus Americana*. London, Can., June, 1893. Herb. D. No. 2122.

Distinct from *G. Carpini* (Lib.) and from *G. Robergii* Desm., which have conidia over 10μ long.

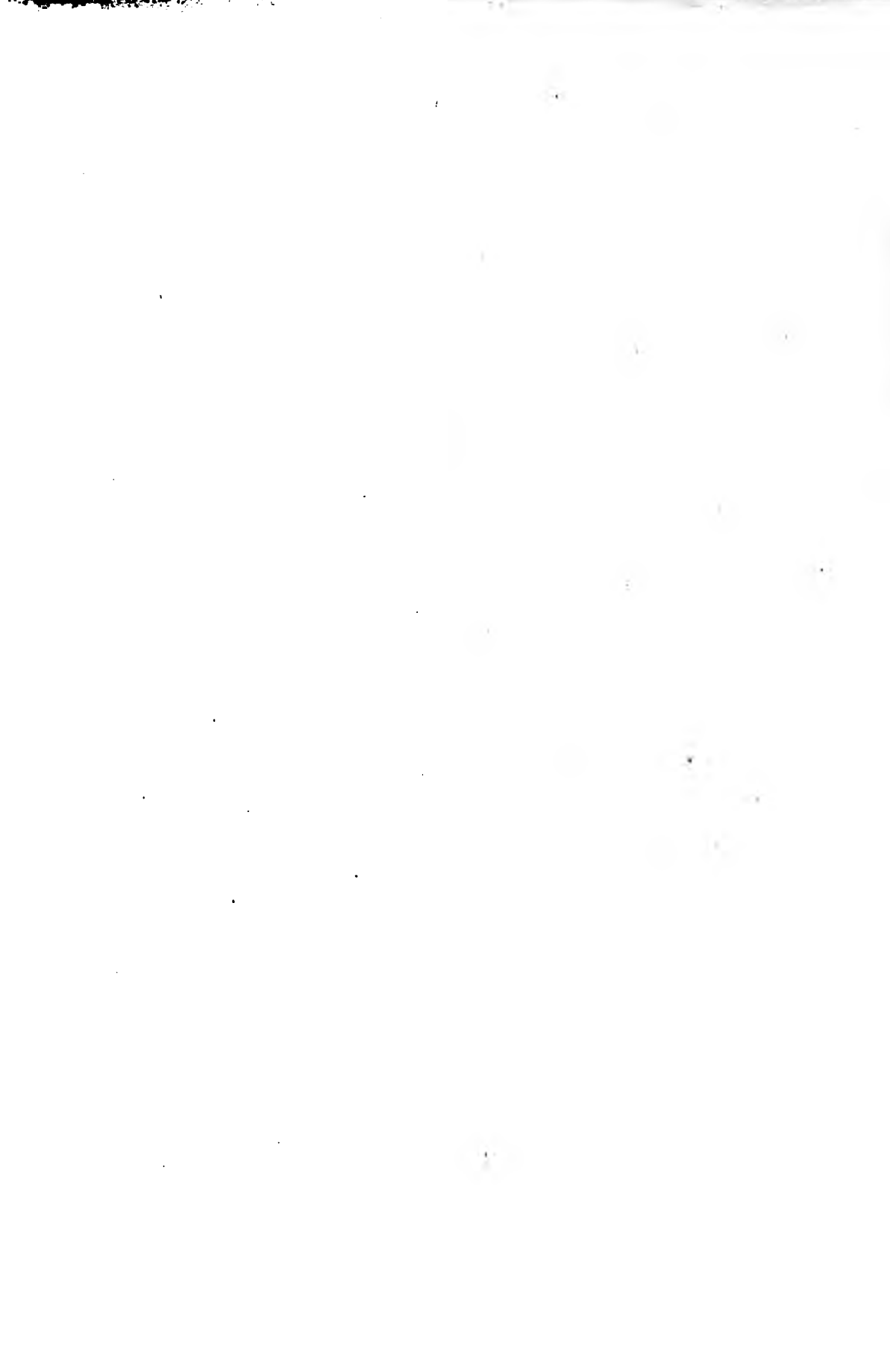
GLOEOSPORIUM CONFLUENS, E. & D.

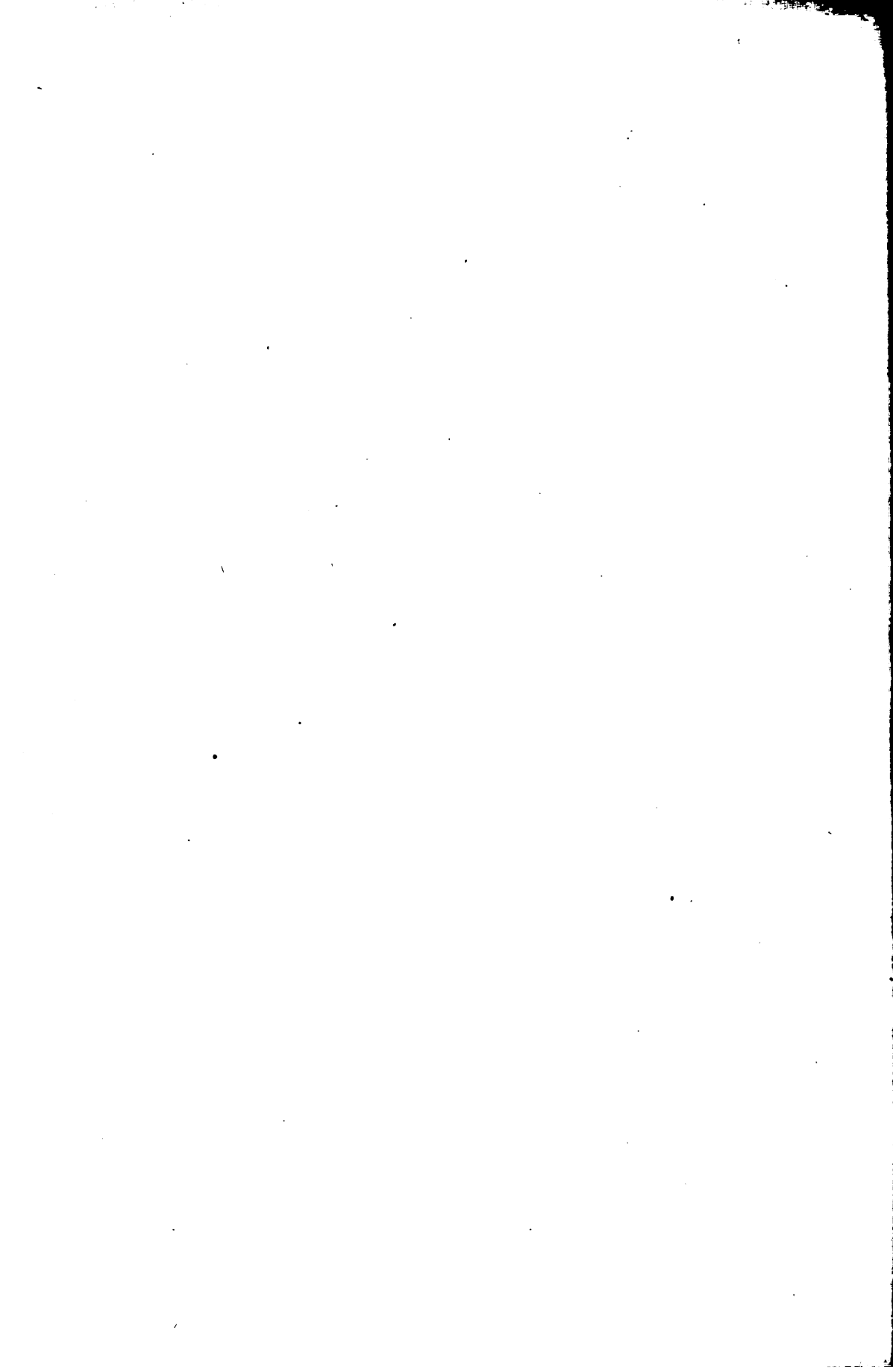
Spots small, $\frac{1}{2}-3$ mm., sub-orbicular, greenish at first, becoming horn-color and finally dull white and transparent in drying, often confluent over a large part of the leaf which then may become rusty brown. Acervuli minute, inconspicuous, soon confluent so as to be indistinguishable and filling the whole interior of the spot with the oblong elliptical, continuous, hyaline, $8-10 \times 3-3\frac{1}{2} \mu$, conidia.

On leaves of *Sagittaria variabilis*. The acervuli also appear on the petioles, and then the conidia are expelled in small white heaps. London, Can., July 1895. Herb. D., No. 2285.

ALAN MACDOUGALL.

Alan Macdougall, F.R.S.E., M. Can. Soc. C.E., M. Inst. C.E., for ten years Secretary of the Canadian Institute, died on 23rd April, 1897, at Exmouth, Devonshire, England, after a lingering illness. For a long time his health had been failing, and early in the summer of 1896 he went to Scotland in the hope that change of scene and a visit to his native land would lead to his recovery. But the hopes of his family and friends were to be disappointed, and he died at the comparatively early age of fifty-five. His services to the Institute as Secretary for ten years were of inestimable value, and numerous papers read by him on subjects more or less connected with his own profession of engineering bear testimony to his scientific zeal and diligence. He was son of the late Col. Macdougall, of Edinburgh, Scotland, and received his education in that city. In 1859 he entered the service of the North British Railway Company, and continued with that company till 1868, when he came to Canada, and became connected with the Toronto, Grey and Bruce Railway, then in course of construction, after which he was employed for about four years in some important lake and river improvements by the Department of Public Works of the Dominion. From 1877 to 1882 he was again in the employ of the North British Railway Company, but in the latter year he returned to Canada, and for a season was a divisional engineer on the Canadian Pacific Railway in Manitoba, after which he engaged in private practice in Toronto until, in 1887, he was made assistant city engineer. As such he conducted some interesting and valuable experiments to determine the velocity and direction of the currents in Lake Ontario, and made surveys in connection with the water supply of the city. He did not long retain his connection with the city service, and after his resignation he devoted his attention chiefly to sanitary science, being consulted as a sanitary engineer by many municipalities all over Canada, from St. John's, Newfoundland, to Victoria, British Columbia. To his enthusiastic devotion to civil engineering is very largely due the formation, in 1887, of the Canadian Society of Civil Engineers, and to the last he bent every energy to the elevation of the status of his profession in Canada. He was an ardent Scot, and took much interest in the work of the St. Andrew's Society, of which society he was elected Secretary for the year 1896; but, unfortunately, his failing health compelled him to resign after a few months' tenure of the office. He was also a member of the Gaelic Society. He was genial and kindly in his intercourse with his fellow-men, and will be long held in grateful remembrance by those who were associated with him on the Council Board of the Canadian Institute.





PUBLIC LIBRARIES IN CANADA. BY JAMES BAIN, JR., ESQ.

(Read December 11, 1897.)

There was a time, shortly after the discovery of printing, when it was possible for a man like Casaubon to say that he knew the contents, more or less thoroughly, of every printed book. But the limits of human endurance were speedily passed, and to-day the enormous mass of literature taxes the ingenuity of the librarian to mould it into organized form. Each successive generation adds its own stratum, and the whole forms the storehouse from which the new generation draws its inspiration and facts. This is especially true of the scientific worker, dependent on the accumulation of minute facts, recorded by long series of patient observers. It is for this reason, therefore, that I bring before you an institution devoted to science, a paper on the "Libraries of the Dominion."

The art of printing was introduced into the infant colonies at a very early period. In Halifax the *Gazette* was published in 1756, the first-born of a numerous progeny, and was followed by the *Quebec Gazette* in 1764. In 1779 a number of the officers stationed at Quebec and of the leading merchants undertook the formation of a subscription library. The Governor, General Haldimand, took an active part in the work, and ordered, on behalf of the subscribers, £500 worth of books from London. The selection was entrusted to Richard Cumberland, dramatist, and an interesting letter from the Governor, addressed to him, describing the literary wants of the town and the class of books to be sent, is now in the public archives, Ottawa. The books arrived in due course, and, while no catalogue survives, I think it would not be difficult to name a large proportion of them. The book world in which Dr. Johnson moved was yet a small one. A room for their reception was granted in the bishop's palace, and as late as 1806 we learn from "Lambert's Travels" that it was the only library in Canada. Removed several times, it slowly increased, until in 1822 it numbered 4,000 volumes. The list of subscribers having become very much reduced, it was leased to the Quebec Literary Association in 1843. In 1854 a portion of it was burned with the Parliament Building, where it was then quartered; and finally, in 1866, the entire library, consisting of 6,999 volumes, was sold, subject to conditions, to the Literary and Historical Society for the nominal sum of \$500.

Naturally, on the organization of each of the provinces, libraries were established in connection with the Legislatures. In Upper Canada the small library in the Parliament Building was destroyed by the Americans, and the one by which it was replaced by the fire of 1824, so that, when the two libraries of Upper and Lower Canada were united in 1841, there appears to have been little left of the early fugitive literature of the province. At the end of the past year the legislative libraries of the Dominion numbered nine, and contained 48,834 pamphlets and 309,395 volumes. By far the most important of these is the library of the House at Ottawa. Originally established on the union of the provinces of Upper and Lower Canada in 1841, it was successively removed with the seat of government from Kingston to Montreal, to Quebec, to Toronto, again to Quebec, and finally to Ottawa—a wandering life, which effectually prevented its attaining large proportions.

The unfortunate fires in Montreal and Quebec still further injured it, robbing it of much that was very valuable, and which could not be replaced. On the federation of the different provinces, in 1867, the library of the two provinces only passed into the hands of the Federal Government. The beautiful building in which it is placed behind the House of Parliament presents a prominent feature in the magnificent pile of buildings which crown the heights overlooking the Ottawa River, and from the windows the spectator gazes across the rocky gorge and the

Chaudiere Falls toward the Laurentide hills, forming one of the most picturesque scenes on the continent. In the eyes of the librarian the library has only one serious defect—it is complete—no arrangement has been made for extension.

On the confederation, in 1867, of the provinces which now form the Dominion, the union which existed between the provinces of Upper and Lower Canada was dissolved, and, as we have seen, the library passed into the hands of the Federal Government. Each of these provinces, now known as Ontario and Quebec, established new libraries in Toronto and Quebec city.

The sixty-two colleges and universities of the Dominion are provided with libraries containing 627,626 volumes and 24,894 pamphlets, an average of 10,123 volumes and 402 pamphlets. It is scarcely fair, however, to depend on an average of the whole number, as some half dozen universities possess at least half of the total number.

The senior of these, Laval University, Quebec, is famous as being, after Harvard, the oldest on the continent, being founded by Bishop Laval in 1663. During the dark days which witnessed the long struggle, first with the Iroquois and afterwards with the English and Americans, little progress was made in the collection of books, and it was not until it was converted into a university, in 1852, that its library commenced to increase rapidly. On the suppression of the Jesuit Order and seminary these books were transferred to it. It numbers considerably over 100,000 volumes, and is unrivalled for the extent and character of its French collection and its many scarce books in early French-Canadian literature and history. Their collection of the relations of the early Jesuit missionaries is only surpassed by the Lenox library, New York.

Our own Province of Ontario was for long the only one which attempted to grapple with the question of public libraries.

Miss Carnochan, of Niagara, has given an interesting account in the Transactions of this Institute for 1895, of the formation and history of the first circulating library in Upper Canada (1800-1820), established by some enterprising citizens of the Town of Niagara, for the supply of their own immediate wants and of those who could pay the small annual fee. It was successful until the destruction of the town by the American troops in 1813 wasted its volumes and impoverished its subscribers, so that it shortly after quietly passed out of existence.

In 1848 the late Dr. Ryerson drafted a School Bill which contained provisions for school and township libraries, and succeeded in awakening a deep interest in the subject. Ever anxious to impress on his hearers the importance of libraries as the keystone to a free educational system, he urged it on every opportunity. Lord Elgin, at that time Governor-General, was so strongly impressed with the importance of the movement that he styled it the "Crown and glory of the institutions of the province." In 1854 Parliament passed the requisite Act, and granted him the necessary funds to carry out his views in the matter. The regulations of the Department authorized each county council to establish four classes of libraries:

An ordinary common school library in each schoolhouse for the use of the children and ratepayers.

A general public lending library, available to all the ratepayers in the municipality.

A professional library of books on teaching, school organization, language and kindred subjects, available for teachers only.

A library in any public institution under the control of the municipality for the use of the inmates, or in any county gaol, for the use of the prisoners.

To aid this work a book depository was established in the Education Office to enable the smaller libraries to obtain readily good literature. The books were supplied at cost, and a grant of 100 per cent. on the amount remitted was added in books by the Department. During the thirty years of its existence 1,407,140 volumes were so supplied.

The proposal to establish the second class was, however, premature, and accordingly, finding that Mechanics' Institutes, supported by members' fees, were being developed throughout the many towns and villages, the Educational Department wisely aided the movement by giving a small grant, proportionate to the amount contributed by the members, for the purchase of books, and reaching a maximum of \$200, afterwards increased under altered conditions to \$400 annually. In 1869 these had grown to number 26, in 1880, 74, and in 1896 to 292. The number of books possessed by these 292 libraries was 404,605, or an average of 1,385 each, with a total membership of 32,603. The issue of books for home reading was 700,958, or an average of 24.6 for each member, which is a very creditable return, considering that only thirty per cent. of the books were fiction.

In 1895 the Minister of Education brought in a bill, which came into force in May, changing the name, "Mechanics' Institutes" into "Public Library." By this Act the directors of any Mechanics' Institute were empowered to transfer the property of the Institute to the municipal corporation on condition that the library be free. This can be done without passing a by-law or requiring a vote from the people. A large number have already availed themselves of it.

In the cities and larger towns, however, the Mechanics' Institute, with its limited number of subscribers, was found unequal to the task assigned it, and accordingly, in 1882, the Free Libraries Act was passed, based upon similar enactments in Britain and the United States.

The first Free Library established under the Act was in 1883, and in the period between that date and 1896 fifty-four have successfully come into operation. They contain 254,091 volumes and circulated during 1895, 1,216,407. Two of them, Toronto, and Hamilton, take rank, both in number and character of their books, among the best libraries of the Dominion.

Unitedly the 346 Public and Free Libraries of the Province of Ontario have on their shelves 658,696 volumes, and supplied in 1895, 1,917,365 books to their readers. Their revenue was \$183,688, of which \$42,741 was contributed by the Province, and they spent of this in books \$49,417.

The Province of Quebec has not yet introduced a Free Library Act, but the generosity of the late Mr. Fraser and of a number of gentlemen in Montreal has provided a fund for the establishment of a Free Library in that city, which was opened in October, 1885, under the title of the Fraser Institute. The Mercantile Library Association transferred to it 5,500 English books and L'Institut Canadien 7,000 French.

In St. John, N.B., a Free Library was founded in June, 1883, to commemorate the landing of the Loyalists a century previous, and in Halifax a Free Library owes its origin to the generosity of the late Chief Justice Young, both of which have been very successful. A sister society, the Library and Historical Society of Manitoba, has been the means of introducing a Public Library, and, with the assistance of the municipal authorities of Winnipeg, has laid the foundation of an extensive and valuable library.

In the lack of trustworthy information, I have not attempted to give any particulars of the Law, Medical, Scientific, Collegiate Institute and Young Men's Christian Association Libraries, further than they are summed up in the following condensed tables, showing the character, and the Province in which they are placed, of the 480 libraries of a more or less public character in Canada.

KIND.	No.	PAMPHLETS.	BOOKS.
Law	21	1,929	105,788
Legislation.....	9	48,834	309,395
Public	325	17,535	663,125
Collegiate, etc.....	62	24,894	627,246
Others	29	15,224	96,918
Special	2	14,330	18,500
Y. M. C. Associations	32	23,660
Totals.....	480	122,746	1,874,632

By provinces the 480 libraries are distributed :

PROVINCE.	No.	PAMPHLETS.	BOOKS.
Ontario	374	32,922	942,187
Quebec.....	39	31,841	531,356
Nova Scotia	26	17,756	97,521
New Brunswick	15	2,689	54,787
Prince Edward Island	3	500	8,528
Manitoba.....	8	5,014	34,730
British Columbia.....	10	1,554	11,303
North-West Territories	1	140	2,150
	476	93,416	1,682,572
Dominion	4	29,330	192,060
Totals.....	480	122,746	1,874,632

We may conclude, therefore, from these figures, that so far as the ordinary reader and University student are concerned, Ontario, at least in the cities and towns, is not badly served. The percentage of books per head is not unworthy of a Province which has only been redeemed from the wilderness during the past fifty years. In two directions, however, do we find shortcomings, if not actual want. Outside of the larger cities, towns and villages lies a large proportion of the population of this Province as well as in the others, which are entirely without access to books. There are whole townships and numbers of villages where the weekly newspaper is the only connecting link with modern science and literature.

If we wish to create an attachment by the farmer for his farm, to give an interest in life to his children in their surroundings instead of in the city, and, in other words, to lay the basis for a successful and pleasant country life, we must try to make his intellectual surroundings more attractive and profitable.

And this is not a new problem. Men who have had their country's good at heart have tried for years to meet the difficulty. The late Dr. Ryerson, as we have seen, attempted to make every school-house in the country a centre of "light and sweetness" by the school library, but failed because the effort was premature and because no effort was made to add to or exchange the books.

Since 1892 an effort has been made in New York State to meet it in a different manner. The State law of that year authorized the Regents of the State Library to lend for a limited time selections of books from the duplicate department of the State Library, or from books specially given or bought for this purpose, to Public Libraries under State supervision or to communities meeting required conditions. Out of \$25,000 appropriated for Free Libraries, a portion was at once set apart to buy and prepare books to be loaned under these rules.

The rules then adopted provide that a selection of one hundred books may be lent for six months to the trustees of any Public Library in the State on payment of a fee of five dollars to cover the expense of cases, catalogues, stationery and transportation both ways. Where no such library exists, the books will be lent on petition of any twenty-five resident taxpayers. Special collections of books may also be lent to the officers of a University extension centre, reading course or study club, if properly registered. A later rule offers selections of fifty volumes for a fee of three dollars. In 1893 the Librarian at Albany began to send out a number of small libraries, of 100 volumes each, to such of the small towns and villages as were not provided with Free Libraries. One of these small libraries remained in the community but six months, and was then exchanged for another—hence the name "travelling libraries," which has been applied to them.

The leading purpose seems to have been to incite communities to found permanent local libraries, but the scope of the work has been widened, and the system now provides smaller collections of books for rural communities. So successful has it proved that in 1895 the State of Michigan appropriated \$2,500 to buy books for a similar system and in 1896 the State of Iowa set aside \$5,000 for a like purpose.

In the same year Mr. Hutchins reports to the State Library Commission that in two counties of Wisconsin similar work had been commenced by private individuals. He says that each small library was put up in a substantial case, with double doors,

a lock and key, and so carefully packed that it could be safely shipped by freight. It was provided with a complete but simple system of blank records, so that it could be placed upon a table or counter, unlocked, and be ready for as effective and methodical work as any larger circulating library. In order to insure good care for the volumes and a continuous local interest, the libraries were only sent to communities which organized a local library association of twenty members who agreed to care for the books and to place them where they would circulate freely under the simple library rules prescribed. Each local association elected a secretary, who acted as its executive officer, and each paid a fee of one dollar for each library as a partial payment of the transportation charges.

Twenty-six libraries in one county were sent out in this way. They were visited about two months after by Mr. Hutchins, and he found them even more popular than had been expected. The most interesting accounts are given of the avidity with which the young especially seized the books. The movement is yet too young to allow of accurate statistics, yet they have proved that in Wisconsin, as in New York and Michigan, they supply an urgent need that has not been supplied by any other agency.

They have carried into hundreds of homes new thoughts and information, higher aspirations and ideals, new forces that are making for a better individual, family and social life. Their books are warmly welcomed by families whose doors are closed to the reformer or the missionary. Hundreds of small communities in Wisconsin have attempted to do such work for themselves, but have nearly always failed. They have raised money by entertainments or private subscriptions, and have started libraries with high hopes. In most cases their selection of books has been unfortunate, and when the few entertaining books have been read by most of the patrons and no new volumes are added the popular interest dies, and the library is either put in an obscure place or its volumes are scattered.

By the new system only wholesome and entertaining books are bought, and they are constantly appealing to new readers until worn out by use, and not merely shelf worn. Every six months a library is new to some public, and its arrival is a matter of comment and draws new interest to the library station. The books are bought at the lowest, and substantial editions are selected. They can be occasionally examined and repaired, an important economy, for with books as with clothing, a "stitch in time saves nine." In the making of rules and regulations a wide body of experience can be drawn upon, and in the printing much economy exercised.

Finally, it practically takes the selection of the reading of great numbers of untrained readers from the hands of blind chance, and puts it in the custody of trained experts, who can draw for assistance upon the library experience of the world. Our great and costly system of public schools works unceasingly to teach children how to read and then leaves too many of them to go through their adult lives without using that power to the best advantage, because of lack of opportunity.

The travelling libraries offer an unexpectedly cheap, efficient and practicable method of broadening our educational system to include in its beneficent purposes every one who goes out from the brief course of our common schools, and to enable them to pursue a life-long system of education.

Such a system as has been described seems feasible in Ontario. No part of the Province is beyond reach by rail or steamer, and in no part need there be lack of readers. Our school system, by providing school sections of moderate area, each with its school-house and teacher, seems to have placed the machinery ready to hand. In Wisconsin about one-third of the libraries are kept in the postoffice, one-half in farm houses and the remainder in small stores. But with the school master as librarian and the school-house as the distributing post, the most widely-scattered farm population could be easily reached, while the results of the daily tasks would be more satisfactory. By supplying also in this way the smaller existing Public Libraries, which are barely able to add to their collections, boxes of 100 new books

every six months, fresh life would be thrown into them and their readers brought into contact with the literature of the day.

The Minister of Education might justly consider the proposal to curtail the grants for libraries, amounting to over \$42,700, and devote the saving to the establishment of travelling libraries.

The second want is found at the other end of the scale. Our best libraries have not reached the stage of meeting the wants of our best scholars, and with the limited means at their disposal the time seems far distant when they will be able to do so. Rivalry is out of question with such great libraries as those of Harvard, the Astor-Lenox, Smithsonian, and others in the United States, not to speak of Great Britain, France and Germany, or even Russia; but if our students are to remain at home, some provision must be made to meet their wants. As a nation we cannot afford to be entirely dependent upon others for our highest culture, so that it is incumbent on us to consider carefully our position, and if possible, by combination and economy of energy, endeavour to supply our want.

We have in the City of Toronto some fifteen, more or less, public libraries, all of which, except four, are devoted to special subjects. These four are: the Legislative Library, the University of Toronto, the Public Reference Library, and the Canadian Institute. The first three mentioned are somewhat on the same lines, special departments being added to each to meet special requirements. In the past efforts have been made by the librarians to prevent the duplication of expensive books and sets; but necessarily a large proportion of the books are alike, and much waste of money, time and energy has ensued. The Legislative Library, established to supply the demands of our legislators, has been forced to add to its shelves quantities of general literature. It has now outgrown the chamber provided for it, and it will be necessary for the Government at an early date to provide further accommodation. The City Public Reference Library has in like manner grown to about 45,000 volumes, which are housed in a building unsuitable for the purpose—exposed to danger from fire and in need of additional space for expansion. The Canadian Institute, with its valuable collection of Transactions, is in much the same condition, with the additional disadvantage that the student finds here only a portion of his work, though an important one, and a lack of proper catalogues and literary assistance.

We have here three libraries which partially overlap and which fail to make full use of their opportunities by reason of special circumstances, and yet which if worked in harmony would do much to remove the present reproach.

It has seemed to me, after careful consideration, that the best interests of the Province and city would be served by adopting a proposal such as the following:

The Province of Ontario and the City of Toronto to unite in the maintenance of a common Provincial Reference Library, the books in which would be free to every person in the Province.

The Province, in consideration of the value of the books in the Public Library, to erect suitable buildings in a suitable locality.

The Legislative Library to be confined to such books as are actually required for legislative purposes, and the balance of the books transferred to the joint library.

The Canadian Institute to hand over their collection to the joint library, receiving in consideration a suitable meeting room.

Regulations made by which students in all parts of the Province could share in the use of the books, due regard being had for their safety.

In this way a library could be instituted—free to the citizens of Toronto, as their own is to-day—furnishing the highest literature to every student in the Province, properly housed with little more expense than the three libraries are at present costing, in which would be found room for extensive geological, mineralogical, botanical and other departments, so much wanted, forming a National Library worthy of the Province and of the City in which it is placed.

NIAGARA AS A TIMEPIECE. BY DR. J. W. SPENCER.

(Read January 22, 1898.)

Although probably a thousand papers have been written upon Niagara, commencing with the discoveries of La Salle and Hennepin, it is still less than twenty years since the physical history of the river began to be understood. La Salle and Hennepin visited Niagara, accompanied by an Indian chief, in 1678. Although they were the first white men who saw Niagara, its existence was made known by Indians to Jacques Cartier when he visited Montreal in 1535. Hennepin's rough sketch of Niagara appears to have been the only one made for a long time. The oldest drawing approaching accuracy, known to the writer, was one made by Lieut. Pierie in 1768.

In spite of the prejudices then existing against the antiquity of the earth, Andrew Ellicott, the surveyor and engineer, more than a hundred years ago, recognized that the gorge had been excavated by the river, and concluded that its age was about 55,000 years. Subsequent estimates were made, but that of Sir Charles Lyell became the most popular. Upon his conjecture that the Falls receded a foot a year, he estimated their age at about 35,000 years. Prof. James Hall made the first instrumental survey of the cataract in 1842, from which comparisons of the amount of recession can now be made. In 1890 the fourth survey was made, and the mean annual recession was found to be about four feet. This factor would reduce the age of the Falls to between 9,000 and 10,000 years, had it been a case of simple, uninterrupted recession. But as the volume of water and the descent of the river have varied so as to increase the time required, the estimate made by Lyell was nearer the true one. Subsequent to the classic writings of Lyell and Hall, of more than fifty years ago, one of the first papers which reopened the study of the physics of the river was written by the writer, in 1881, showing that the Erie basin was not drained by the Niagara river in pre-glacial times. This was confirmed by Dr. Julius Pohlmaes, who, two years later, discovered certain fragments of ancient streams, the valleys of which were taken possession of by the modern Niagara. Again, Prof. G. K. Gilbert found, in 1886, that the river had a greater descent at one time than now; but the earlier, long-continued and inferior height of the Falls was first pointed out by the writer. Upon the backing of the water after the maximum descent of the river, the surface of Lake Ontario rose above the present level, so as to again considerably reduce the height of the Falls. This second reduction of their height is, perhaps, the last discovery in the physics of the river, and has hitherto not been announced.

Perhaps the most important change discovered in the physics of the river was (in 1887-1888) that the three upper lakes—Huron, Michigan, and Superior—did not drain into Lake Erie until recently, but emptied, through Georgian Bay, towards the north-east. Thus for a long period Niagara river drained only the waters of the Erie basin. These discoveries show that the determination of the mean rate of recession of the modern Falls had to be greatly qualified in order to arrive at an approximate determination of the age of the cataract; but the difficulty remained of ascertaining the amount of work done during the different episodes. However, at Foster's Flats the bed of the old river and fragments of lateral terraces were found in 1893. From these and other features the key to the situation was partly obtained. Some of these results have since been confirmed by the estimate of the depths in the different basins of the modern channel made by Prof. Gilbert.

The modern Niagara took possession of the old Tonawanda channel, which had drained a portion of the Niagara tableland in pre-glacial times. Its valley was about one and a half miles wide and ninety feet deep, and crossed the course of the modern river. The rapids above the Falls represent the site of the modern waters, now descending over its side into the ancient Tonawanda channel, which had been filled with drift. This ancient valley is now buried, and continues westward of the whirlpool to form the St. David's Valley, about which so much has been written. The whirlpool gorge is only a modern enlargement of a small valley starting, in pre-glacial times, from near where the railway bridges are now located, and forming a little tributary of the Tonawanda channel, just mentioned.

The older geological features and the character of the strata have been known for fifty or sixty years, but the features here mentioned are those directly bearing upon the physics of the river, which were not formerly understood.

The episodes of the river may be briefly outlined. The first was of long duration, when the descent of the river was about 200 feet, and the volume of water one-fourth of that of the present amount (only the drainage of the Erie basin). Then we have all the waters of the upper lakes flowing over Niagara, and shortly afterwards the surface of Lake Ontario was lowered to 420 feet below the upper level of the river. Thus, in a general way, we have arrived at the time when the Falls had reached the foot of the whirlpool rapids, by which time the waters of the Ontario basin rose sixty feet or more above their present level. In the meanwhile there were three principal cataracts, the lower gaining upon the upper. But by the time the Falls had retreated to just above where the railway bridges cross the gorge the Ontario waters were again lowered, so that the modern descent of Niagara river is 326 feet. The physics of the short section along the whirlpool rapids is not yet understood; but even in spite of this, with the consequent errors in the theoretical determination, the age of the Falls so far has not been found to greatly differ from the computations made in 1893, which assigned the period between the time when the Niagara was a strait and the present day to be 32,000 years.

These changing episodes, which appear complex, are after all largely assignable to one cause, namely, the unequal elevation of the earth's crust in the lake region, the amount being greater towards the north-east than in the opposite direction. With the rise of the land, the Huron, Michigan and Superior, collectively named the Algonquin basin, was eventually drained by way of the Nipissing and the Ottawa valleys; and the waters of the Lundy basin, the name for the united Erie and Ontario basins, were lowered so as to leave only an insignificant Lake Erie, and the Iroquois gulf, extending in the Ontario basin to the foot of the escarpment at the mouth of the Niagara river, into which the Falls descended directly at their birth. With the continued rise of the land the waters of the Ontario basin sank, in so far as they affected Niagara, to eighty feet below their present level. The land, now rising more rapidly towards the north-east than the south-west, tilted the river of the Algonquin basin so as to raise a barrier across the Nipissing outlet (worked out by Mr. F. B. Taylor), which diverted the waters of the upper lakes into the Niagara drainage only some 7,000 or 8,000 years ago. The same kind of movement raised the barriers at the outlets of both Lake Erie and Lake Ontario so as to back their waters towards the heads of the basins; and, in the case of Lake Ontario, its surface rose some sixty feet or more in the lower part of the Niagara gorge. But a portion of the barrier at the outlet of Lake Ontario, being composed of drift, has recently been washed away by the St. Lawrence river so as to reduce the surface of Lake Ontario to its present level.

The movement is slow. The rise of the land in the Niagara district is about one and a quarter to one and a half feet a century; about the region of Lake Nipissing, nearly two and a half feet, and about the outlet of Ontario, between four and five feet a century. These upward movements were determined from geological observations made at Niagara, and their effect upon the tilted beaches, which had

been traced over the lake region; but until 1893 all attempts made at determining the rate of terrestrial changes defied investigation. The north-eastward movement is still continuing, as recently determined by Prof. Gilbert. Under these conditions further changes in the drainage of the upper lakes become imminent: thus the rocky barrier at Niagara Falls should be lifted so high in 600 or 700 years as to flood the country about the head of Lake Erie, and raise its surface to the same level as that of Lake Huron and Lake Michigan. In 1,000 or 1,200 years they should be high enough to overflow the low divide near Chicago into the Mississippi drainage. In about 2,400 years all the waters of the upper lakes promise to be diverted from Niagara to the Mississippi. The Chicago canal is not considered in this calculation, but will shorten the time of the last-named events. These calculations, based upon geological data, are very close to those of Prof. Gilbert, based upon other measurements. In the meanwhile the waters about Buffalo will rise somewhat higher than now, but in 5,000 years the whole of the Niagara river and the eastern end of Lake Erie will be turned into dry land, traversed only by insignificant streams. From the time when the whole discharge will be turned into the Mississippi there will be but little further excavation of the Niagara gorge. Before this change is accomplished, the Falls will have receded scarcely two miles farther southward; and thus for only a small proportion of their life history will they have been of use to man, or their grandeur remain as one of the wonders of the world.

The birth of the Falls was subsequent to the commencement of the lake history, which was posterior to the ice age proper. Upon the computation of the age of the Falls (32,000 years) it has been found that the end of the ice age was more than 50,000 or 60,000 years ago.

THE CREE LANGUAGE. BY REV. E. B. GLASS, B.A. (VICTORIA).

(Read January 29, 1898.)

I.

Of the Algonquin stock, the Plain and Wood Crees use, perhaps, the purest and most euphonious branch amongst the Cree dialects:

EUPHONY.

On the Saskatchewan 'duck' is 'sesep'; 'duckling,' 'sesepis.' At Moose Factory these words are 'sheshep' and 'sheshepish.' The former two words please the eye and ear, and are readily enunciated. There is a natural tendency to place a vowel between consonants in order to secure agreeable sounds. 'Iron' or 'metal,' is 'pewāpisk,' 'road' is 'māskunow' and 'rail' or 'iron-road' is 'pewāpisko māskunow.' 'Kīyās,' 'old,' 'kākwīya,' 'things'; 'old things' is 'kīyāse kākwīya.'

These Indians do not stammer—they are noted for ready utterance and eloquence. Rapid delivery is necessary on account of the syllabic character of the language, as distinct from the alphabetic of the English and most European languages; therefore euphony must be studied to aid pronunciation. I shall give an illustration:

"The new Government wishes to know how the Crees are prospering," has sixteen syllables. This in Cree is, "Kā ōske *puminā'kik weyusoowāwin wekiskāye'tumwuk mā'te kespīn Nāheyāwā peyechechenākoo'chekāyekwānik," and contains thirty-seven syllables. Hence it can be seen that to convey the same idea in the same time as the Englishman, the Cree must speak more quickly.

PRECISION.

There is a definiteness about this tongue that is very striking, and in contrast to the ambiguity of many other tongues. If an elder brother is referred to it is 'nistās,' 'my brother,' if a younger brother, the word is 'nisēm.' My (elder) sister is 'nimis'; 'my (younger) sister,' 'nisēm.' It is observed that 'nisēm' is either 'my (younger) brother' or 'my (younger) sister'; but it is usual to add, in this case, by way of explanation, 'nāpāo,' 'man,' and 'iskwāo,' 'woman,' as 'nisēm iskwāo.'

All verbs are precise in first and second plural, and third singular and plural. In English, French, Latin, Greek, "we advise," for instance, is indefinite; but in Cree these forms of the verb leave no doubt in the mind of the reader or hearer addressed. "Ne se'ke'kāmūnān," "we advise," excludes second person or persons, including only first and third; "ke se'ke'kāmūnow," "we advise," takes in first and second only.

In addressing the Deity it is unpardonable to say "kemoostowinānow," "we desire it," which form embraces the first and second persons; "ne moostowinānān" must be used.

If I ask a friend whether Mr. Jackson's son is home, the answer is "āpēyewa," not "apēu"; the latter word is, in substance, "he is home," and refers to Mr. Jackson himself; but "āpēyewa" has the relative ending "yewa," relating to the second party mentioned, that is, the son.

My friend may then say, referring to Jackson and son, "nāṭawāye'tum kita pāetu'tāt ootā" "he desires to come here," that is, Jackson. If it is said, "nāṭawāye'tum kita pāetu'tāyit ootā," the relation extends to the son, and the meaning is that Jackson wishes his (son) to come here."

(*The Greek or Scotch aspirate ['] cannot be omitted in many words.)

No one can dispute the ambiguity of the following: "The chief spoke to the thief in his house." Such indefiniteness has no place in Cree. If the chief's house is meant the sentence is, "Okemow ke weche pekiskwāmāo okimotiwa weki'k"; if the thief's house is meant, the last word has the relative (relating to another) ending "yi'k" added, making "wekeyi'k."

Suppose that a man wishes to take a horse home. The form of verb he employs indicates whose horse. If his own horse he says, "Ne kā kewā'tahow," "I will take him home." If another's, "Ne kā kewā'tāhimowā," "I will take his (horse) home."

SYNTHESIS.

A few examples will give some idea of the constructive peculiarity of this language.

The root "wā" signifies "light" or "white colour." By a system, the Cree has added to this root endings that are significant and unique: "Wāpeo," "he sees"; "wāpewin," "sight"; "wāpamun," "mirror"; "wāpā'tum," "he sees it"; wāpamāo," "he sees him"; "wāpehāo," "he causes him to see."

Again, upon the root "pim," "coursing" or "going," is built another set of words: "Pimo'tāo," "he walks"; "pimo'tāwin," "walking," *i.e.*, the noun; "pimo'tahāo," "he causes him to walk," or go; "pimē'yow," "he flies"; "pimiskow," "he paddles"; "pimāsiw," "he sails or goes with the wind"; "pimipā'tow," "he runs"; "pimipā'towin," "running"; "pimipāyiw," "he passes running"; "pimipāyiwīn," the noun "running" in passing by.

II.—THE NOUN.

There is a disposition on the part of some to underestimate the importance of the noun in Cree. It is difficult to see the reason of this when it is considered that the language abounds in names of all kinds conceivable, and possesses the genius or ability of naming everything that civilization presents as new. It is true that many nouns are formed from verbs by prefixes and modified endings, but this fact is no argument (as will be seen) that the noun is not a prominent part of speech or that it does not naturally occur in the language.

1. Names are given "directly" to objects—*kēsik*, sky; *atim*, dog; *asinee*, stone; *nipē*, water; *nāpāo*, man; *kōna*, snow; *pimē*, oil, grease; *mūstūs*, a cattle beast; *mūswā*, moose; *muskwā*, bear; *minahik*, pine; *askē*, earth, a country; *pē'kō*, ashes; *mē'kō*, blood. In the last two words the "rough breathing" of the Greek is used, to secure the *h* sound in English, after *ē* in each word. The force of the breathing is exactly the same as that in the name *Lochaber*, a district of *Inverness*.

2. Names are given "indirectly"—that is, they are suggested or derived:

(a) Of these the verb originates many nouns by the prefix *ō*, as *kistekāo*, he farms; *ōkistekāo*, farmer; *āyamehow*, he prays; *ōtāyamehow*, one who prays, a Christian. The *t* is here inserted between two vowels for easy utterance, or euphony. *Mēyosoo*, she (mas. or fem.) beautiful; *ōmēyosoo*, the beauty. *Kēyāskēw*, he lies; *ōkēyāskēw*, a liar.

(b) The verb originates other nouns by an affix, or by both prefix and affix, to the third person, singular, present tense. *Nikumoo*, he sings; *nikumowin*, singing. *Chēkiēkāo*, he chops; *chēkiēkāwin*, chopping. *Tipahumākāo*, he pays; *tipahumākāwin*, payment. *Nipā'tākāo*, he commits murder (mas. or fem.); *ōnipā'tākāsk*, a murderer. *Āyumēhā'kāsoo*, he pretends to pray; *ōtāyumēhā'kāsus*, a hypocrite. The last three examples show that nouns may be formed by a prefix and the affix *sk* to a modified ending.

(c) By dropping the ending of the third person, singular, and adding *kān*, nouns are derived from verbs: *Kēskēpoochēkāo*, he saws (crosswise); *kēskēpoochēkān*, cross-cut saw. *Tāskēpoochēkāo*, he saws (lengthwise); *tāskēpoochēkān*, rip-saw. *Pēkopichēkāo*, he plays; *pēkopichēkān*, plow.

(d) In a number of cases the noun formation consists in omitting the pronominal prefix of a verb, third, singular, and adding *kun* or *chēkun* to the ending, from which the consonant is elided. Ne *mini'kwān*, I drink; *mini'kwākun*, or *mini'kwāchēkun*, a cup, or drinking vessel. Ne *kāse'kwān*, I wash my face; *kāse'kwākun*, wash basin.

(e) A class of nouns is formed from other nouns by adding *kān*, a vowel being inserted between the consonants, the new formation denoting something simulative or artificial. *Awāsis*, child; *awāsisē'kān*, doll. *Pesim*, the sun; *pēsimo'kān*, a clock. *Manitoo*, God; *manito'kān*, an idol. *Pā'kwāsekun*, flour; *pā'kwāsekunē'kān*, wheat; in this derivative one would expect the word for flour to be derived from that which signifies wheat, according to rule, but this is the exception.

(f) If *wān* is added to the name of an animal, a name is obtained for that animal's skin. *Wāpoos*, rabbit; *wāpooswān* rabbitskin. *Mooswā*, moose; *mooswān*, mooseskin.

By affixing *wāgin* to the same names of animals, a name for a part of the skin is supplied. *Moostoos*, a cattle beast; *moostooswāgin*, a piece of oxhide, or leather. *Mooswāgin*, a piece of mooseskin. These derived cognate nouns are much in use. The word for book is *musin'fēkun*; if *āgin* is added, as in *musin'fēkunāgin*, the name for paper is obtained. *Papakēwān*, shirt; *papakēwānāgin*, shirting.

(g) Diminutives are formed by means of an affix "is," "oos," or an ending of like sound. *Sēsēp*, duck; *sēsēpis*, duckling. *Nāpāo*, man; *nāpāsis*, boy. *Iskwāo*, woman; *iskwāsis*, girl. *Mā'kā'k*, barrel; *mā'kā'koos*, keg. *Musin'fēkun*, book; *musin'fēkunis*, letter. *Musin'fēkunāgin*, paper; *musin'fēkunāginooos*, a bit of paper. *Sēpē*, river; *sēpēsis*, creek. *Misehāo*, hen; *misehāsis*, chicken.

(h) By affixing *āpwē* to a noun or an adjective, the name of a liquid is obtained. *Iskootāo*, fire; *iskootāwāpwē*, fire-liquid or whiskey. *Musin'fēkun*, book; *musin'fēkunāpwē*, ink. *Sēwow*, it is sour; *sēwōpwē*, vinegar. In this last word, by eliding a vowel and a consonant, a euphonious word is formed.

(i) If *ā'tik* is added to a noun, an appurtenance or part is designated. *Musin'fēkun*, book; *musin'fēkunā'tik*, pen. *Chēk'fēkun*, axe; *chēk'fēkunā'tik*, axe-handle. *Mētisowin*, eating or food; *mētisowinā'tik*, table.

(j) *Kumik* denotes abode, dwelling, or building, when affixed to a noun. *Mistātim*, horse; *mistātimokumik*, horse-stable. *Moostoos*, cattle-beast; *moostoosokumik*, cattle-stable. *Sooneow*, money, *sooneowokumik*, bank. *Asā'kāo*, he gives rations; *asā'kāokumik*, ration-house.

(k) By prefixing an adjective or a verb to a noun, a composite noun is formed. *Pē'tukāo*, he enters; *āyamehowin*, prayer; *pē'tukāwēāyamehowin*, class-meeting. When *āyamehāo*, he prays, is prefixed to *ēyēnew*, person, there results the long word *āyamehāwēyēnew*, preacher. *Ki'che* is great; *ōkemow* is chief, ruler or king; *iskwāo* is woman. Now, by joining these three in order, and remembering euphony, a significant noun is the result, which means queen. This word is *ki'cheōkemāskwāo*.

“RECENT VIEWS ON COLOUR.” BY ALBERT H. ABBOTT, B.A.

(Read January 29, 1898.)

The colour problem has three aspects :

I. The physical problem, which investigates that energy in nature which is especially connected with our sensation of light and colour.

II. The physiological problem, which investigates the processes in the eye and its accessories as the organ of vision.

III. The psychological problem, which investigates our sensations of colour, or colour as it is experienced. The question here is: What are the mental facts of light and colour, and on what conditions do they depend ?

The first “recent” view on colour discussed was the emphasis which has been laid upon this psychological colour problem with the rise of scientific or experimental psychology. Both of the other aspects, the physical and physiological, must refer continually to the facts of colour which scientific psychology discovers or establishes, as the final test of the adequacy of their theories. The facts of all sciences are *primarily* facts for psychology (*i.e.*, psychic or mental facts), and *secondarily*, facts for these sciences, and hence, the conclusions and theories of all sciences must be judged by their faithfulness to the facts of experience.

The second view on colour discussed was a modification to the ordinarily accepted physical theory of colour, suggested by Dr. Kirschmann. The ordinary theory contends that colour is an explicit function of the wave length. There is a difficulty, however, in this view which is raised from the fact that *no one has ever seen light or a colour of only one wave length*, and, therefore, that, could we get light of one wave length, there is no guarantee at all that we should see it coloured. *Colour of one wave length is a purely hypothetical conception*; at every point on a spectrum there is always a superposition or interaction of wave lengths. A slit *infinitely* small would, so far as mathematics are concerned, give the *pure* spectral colours which advocates of this theory demand; but, on the other hand, a plate bearing a slit which is *infinitely narrow* would be for us an *opaque* object. Colour as seen in the spectrum must actually be projected by use of a slit of finite width, and, therefore, it must always be produced by the superposition or interaction of wave lengths.

This contention is based directly on psychical considerations, *viz.*, whether we *see* colour or not. To contend that that alone would be a *pure* colour which is to be produced under circumstances which would prevent us seeing either light or colour seems to overlook the fact that it is our sensations of colour which make any science of optics possible, and surely they must be the deciding factor in such a matter to the last.

A second line of objection to the theory that colour is an explicit function of the wave length arises in connection with the discussion regarding purple, *i.e.*, the colour which would form the transition from violet to red. This colour is not present in the ordinary spectrum, and from this it has been concluded that purple is not a *pure* but a *mixed* colour, and as such it is not a constituent of white light at all.

An experiment was shown which seems to have some bearing on the question. By very simple means two spectra were thrown upon a screen together, parallel and in close juxtaposition to each other. The one was the ordinary spectrum, consisting of red, orange, yellow, green, blue, violet, and the second was an “inverted” spectrum, consisting of blue, violet, purple, red, orange, yellow. (Note.—Purple is absent from the first, *green is absent from the second.*)* This “inverted” spectrum

* The “inverted” spectrum was first shown in this connection in a lecture given by Dr. Kirschmann before the Mathematical and Physical Society of the University of Toronto. The objection may be raised that the colours in the inverted spectrum are not as “pure” as those in the ordinary spectrum, but this is met by the fact that, as sensations, the colours are quite as pure and brilliant as the ordinary spectral colours. The right of these colours to rank physically the same as the latter colours was further demonstrated in the above-mentioned lecture by the fact that both spectra show interference bands equally well.

is produced by the superposition of two spectra, so that the red and violet rays act together, and so give purple. *The presence of purple, therefore, proves nothing* which could reflect on the ordinary theory, but *the absence of green* is of more significance. If green is a constituent of white light, why is it absent? Where is the green? If we answer, Just where the purple is in the ordinary spectrum, we must undertake a thorough discussion as to the basis of the contention that green is a constituent of white light while purple is not. The fact is, if we prevent the rays of the ends of the spectrum interacting we lose purple, and if we prevent the rays of the middle of the spectrum interacting we lose green. The absence of both of these colours from the spectra seems to be rather a property of the means used in each case than of white light. In white light every wave acts at the same point, while in the longitudinal arrangement of the colours, as in a spectrum, we prevent this; but while allowing the neighbouring waves to act together we deprive the waves of ends of the spectrum altogether of this possibility. Hence, Dr. Kirschmann contends, the absence of these colours in each case. He suggests, therefore, that the theory be modified and stated as follows: "*Colour-quality is a function of the superposition of wave lengths*, so that to every qualitative difference in spectral colours corresponds a difference in the mode of superposition.*

This position goes back to the psychology of the question. If purple were found to play an exceptional role in our colour sensations there might be grounds for rejecting these conclusions. But if, as is the case, purple be found to obey the same laws which all other colour sensations follow, there is no reason whatever for regarding it in any peculiar light. It is a colour quite as much as any other. There is, therefore, no *a priori* reason for rejecting it from the list of *pure* colours. If, however, it must be rejected in the case of the ordinary spectrum, surely green must be rejected in the case of the inverted spectrum from the list of the constituents of white light, and both for the same reason.

The third question discussed was along the line of the general psychology of colour.

Experiments were made, showing that colour sensation could occur when physically there was no light of the specific colour present, *e.g.*, as in contrast phenomena.

The manifoldness of our colour sensations was also illustrated by a geometrical construction known as "the colour cone," and by means of rotating discs, showing transitions in shades, tints and saturations of colour.

The fact that, from the psychological standpoint, there is no reason to speak of fundamental colours was discussed, and the significance of the colour theory of Prof. Wundt was pointed out. Owing to modifications made in connection with this theory recently by Dr. Kirschmann, and in consideration of the modifications suggested to the physical colour theory by the same scientist, it seems proper to give the theory the name of the Wundt-Kirschmann Colour Theory.

* "*Colour saturation and its quantitative relations.*"—*American Journal of Psychology*, Vol. VII., No. 3.

SEISMOLOGICAL OBSERVATIONS AT TORONTO. BY R. F. STUPART, ESQ.,
DIRECTOR METEOROLOGICAL SERVICE OF CANADA.

(Read February 5, 1898.)

At the Ipswich meeting of the British Association it was resolved that the two committees which were studying vibrations of the earth's crust, viz., "The Committee for Investigating the Earthquake and Volcanic Phenomena of Japan" and "The Committee on Earth Tremors" should not be reappointed individually, but that the whole subject should be referred to a new committee, consisting largely of the members of the old committees, which should be called, "The Committee on Seismological Observations." The new committee at Liverpool reported as follows: "This Committee, however, think that it would be well in this, its first report, to state definitely what it hopes to accomplish, and how far it thinks that the British Association should go. It has long been an unwritten rule that the Association should initiate work, but should not charge itself with its maintenance. This is precisely what your Committee desires. Now that it has been proved that any important earthquake is felt all over the globe, the Committee considers that arrangements should be made for the record and study of these movements. Your Committee considers that such records may prove as important as those of *e.g.*, terrestrial magnetism, and, just as we have magnetic observatories in various parts of the world, so, in its opinion, should there be seismological ones. But, before advocating their erection, it is essential that a decision be arrived at as to the form and degree of sensitiveness of the instrument to be recommended.

This, and correspondence connected with the organization of the system, is the work which the Committee desires to complete. Previous reports and the appendices to the present one, show how much has been done in this direction, but the Committee desires to do much more. It wished to place side by side four good patterns of instruments, and to compare and study their records. When this is done it hopes to receive the support of the Association in approaching the Government with the view to the establishment of a limited number of instruments, identical in sensitiveness, in this country, in India, and in the colonies, and of a small central office at Kew or elsewhere for co-ordinating and publishing the results. As far as the Committee can at present judge, the equipment of each station, with complete apparatus for continuous photographic record, would not exceed £100. For the experimental work of the coming year the Committee have one instrument, and can have the use of another (constructed under a grant to Professor Milne by the Royal Society); it wishes to purchase two others, and will have to build piers, etc., and pay for photographic necessities and an assistant to run the instruments, which, altogether, would probably cost over £200. Your Committee thinks it desirable that to meet unforeseen items it should have £250, but without £200 the work cannot go on."

Early in 1897 a letter was received from the chairman of this Committee inviting the co-operation of the Canadian Meteorological Service in a seismological survey of the world. The Honourable the Minister having been pleased to authorize the expenditure of the necessary funds, a seismograph was ordered, and the instrument arrived in Toronto on the morning of the day that Professor Milne gave his most interesting lecture on "Earthquakes" at Massey Hall, and he was able to have it on the table for the inspection of those of his audience who wished to examine its construction. The instrument consists of a horizontal pendulum with a boom two feet six inches long; at the end of this boom is a plate in which is a narrow slit,

parallel to the length of the boom. The position of this, beneath a slit at right angles to it, is shown by a speck of light from a small lamp, reflected down, which photographs continuously on a bromide film two inches wide, which passes at the rate of five feet each day. Every hour the light is eclipsed by a screen attached to the long hand of a watch, and thus a time scale is supplied.

After the departure of the members of the British Association we lost no time in getting the instrument in position, but unfortunately were unable to begin operations immediately, as the maker had failed to send us the necessary paper, and it was not until the 20th September that the clock was set in motion. I say unfortunately, because there was great disturbance on at the very instant the record began, and we have a clear record of the maximum and last vibrations caused by an earthquake which Professor Milne informs us occurred in Borneo.

There are difficulties to contend with in the management of the seismograph, and the greatest of all is vibration of the pendulum, caused, we believe, by some movement of the air. Professor Milne has been unable to altogether get rid of the movement in his instrument in the Isle of Wight; he is inclined to think it is caused by air currents. He has studied the vibrations under various atmospheric conditions, and apparently finds, as we do, that the disturbance is most pronounced on clear, calm nights when radiation is great. It is a subject for investigation, whether we are not registering on our seismograph the very atmospheric tremors or waves which cause telegraph wires to hum on clear, calm nights, and that, Mr. Percival Lowell asserts, are the cause of bad seeing on certain nights which, to all appearance, ought to be good for astronomical observations.

Since the starting of the instrument we have recorded eleven very decided quakes and nine small earth tremors; many others have perhaps been lost in the air current disturbances. The most marked of the eleven was the first one, the origin of which Professor Milne places in Borneo; the next in order of importance occurred on December 19th, when earthquakes were reported both from Bermuda and Italy; this was not recorded in Great Britain. Next came one on December 28th, and was followed by a larger one on the 29th; and both were also recorded by Milne in the Isle of Wight.

The preliminary tremors on the 28th (Fig. 1) began at Toronto at 8h. 24m. 37s., Greenwich mean time, and in the Isle of Wight at 8h. 54m. 51s., or over half an hour later. At present we have no knowledge of the origin of this disturbance. The disturbance of the 29th at Toronto (Fig. 2) was marked by the absence of preliminary tremors, and vibrations of large amplitude began at 11h. 32m. 29s. In the Isle of Wight preliminary tremors began at 11h. 40m. 48s., and the larger waves at 12h. 0m. 37s., or 28m. 8s. later than Toronto. The origin of this disturbance was obviously near the north coast of San Domingo. Two cables were broken by it, and, according to newspaper reports, the town of Santiago was greatly damaged at about 11h. 29m.; which time, however, Professor Milne thinks is an error, and is inclined to place six minutes earlier. The distance from San Domingo to Toronto is 1,510 nautical miles, and to the Isle of Wight 3,823 miles. We are endeavouring to obtain further particulars from San Domingo regarding the time of the shake, and if successful the comparison will be particularly interesting. The last important shock was on January 24th, the preliminary tremors beginning in Toronto (Fig. 3) at 12h. 18m. 28s., or 32m. 39s. later than in England; this would seem to indicate a very different origin from those of December, perhaps in Asia Minor. At the Toronto meeting of the British Association last year Professor Milne obtained a grant for the construction of a few seismographs, and I promised to place one of them in charge of the meteorological observer at Victoria, B.C. The instrument is nearly ready for shipment, and will probably be placed in position about the 1st of June. This will be another link in the chain of seismological stations, and it is pleasant to know that Canada is taking a very active part in this most interesting and important seismic survey.



FIGURE 1.

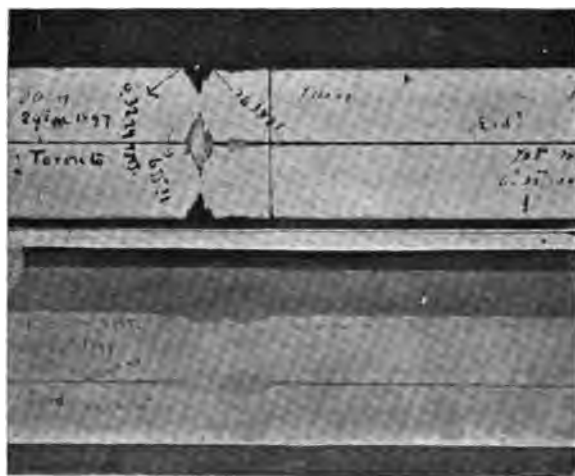


FIGURE 2.

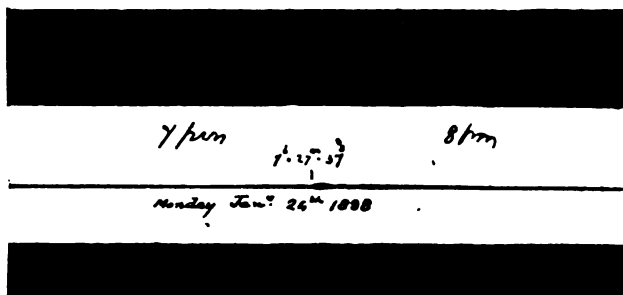


FIGURE 3.

THE GENERAL HISTORY OF THE CELTS. BY REV. NEIL MACNISH, LL.D.

(Read February 19, 1898.)

In the topographical names of the British Isles, in the names of streams and rivers and hills and mountains and lochs and headlands, an argument plausible and strong can be found in favour of the theory, that the Gaelic portion of the Celtic race preceded the Cymri, or Welsh, in the occupation of Britain; and that the Scottish Gaels of to-day speak the same language which our remote ancestors spoke, who, of the Celtic race at least, were the first to enter and inhabit the British Isles. Those whose hearts are warmed with Celtic blood have at least the satisfaction of knowing that they are the descendants of perhaps the oldest race in Europe; and that, although the early appearance of the *Keltai* in that Continent is enveloped in hopeless obscurity, it is true beyond contradiction that their Celtic forefathers were both numerous and powerful long before the English, or German, or French, or Italian peoples had any distinctive existence. The Celtic dialects were strong and well developed and cultivated before any of the important languages of modern Europe were born. Pride of extraction and veneration for genealogies that reach back into the distant past, seem to have an irresistible attraction for the human heart. In the social life of modern days, there is a tacit admission that he is entitled to more than ordinary respect who can establish his contention, that the blood of many respectable generations is coursing in his veins. In addition to the acknowledged antiquity of their presence in Europe, the Celts have the additional satisfaction, that the stream of their particular blood has flowed down with comparative purity during many centuries; and that in the Celts of our day, there is a large absence of that admixture of blood and nationality which is so marked in the Anglo-Saxon race. Mommsen asserts "that the Greek and Italian are brothers, and that the Celts, the German and Slavonian are their cousins." Max Müller thus writes: "The fourth branch of our family is the Celtic. The Celts seem to have been the first of the Aryans to arrive in Europe, but the pressure of subsequent migrations, particularly of Teutonic tribes, had driven them towards the westernmost parts, and latterly from Ireland across the Atlantic. At present the only remaining dialects are the Kymric and the Gadhelic. In former times the Celts not only enjoyed political autonomy, but asserted it successfully against the Germans and Romans. Gaul, Belgium and Britain were Celtic dominions, and the north of Italy was chiefly inhabited by them. In the time of Herodotus we find Celts in Spain and Switzerland. The Tyrol and the country south of the Danube have once been the seats of Celtic tribes; but after repeated inroads into the regions of civilization, familiarizing Latin and Greek writers with the names of their kings, they disappear from the east of Europe." This is the opinion of Latham regarding the *Keltai*: "This stock was indigenous to the water systems of the Loire, the Seine, the Rhone; in other words, to the whole of France north of the Garonne, to the south of which river lay the Iberians. From Gaul it spread to Great Britain. Its present representatives are the Bretons of Brittany, the Welsh, the Gaels of Ireland and Scotland, and the Manxmen of the Isle of Man."

The early annals of Rome record a victory which the Gauls, under their leader, *Brennus*, obtained over the Romans. At Allia, in the neighbourhood of Rome, the Romans sustained so severe a defeat in 391 B.C. that the Gauls were allowed to occupy the city without much or any molestation. Though the inventive genius of Roman historians has thrown a halo of romance over the departure of Brennus and his Gauls from the city, the stubborn fact remains that the Gauls were at that time brave and numerous and powerful. Further, we learn from classic story that

Gauls under the leadership of another Brennus invaded Greece in 279 B.C., and were prevented by some miraculous interposition from gaining possession of the treasures at Delphi. The Gauls were defeated and their leader was killed. After their departure from Greece they crossed into Asia Minor, and finally settled in the province which was known as Galatia—a name which doubtless owed its origin to the Gauls who planted their homes in that portion of Asia Minor. Max Müller and others are of opinion that *Brennus* is akin to the Welsh *Brennin*; and that the meaning of the word in question is *king*. The conjecture may be advanced that, as the two leaders of the Gauls bore the same name, *Brennus* may be regarded as a distinction of office, or as an appellation which every Gaul who occupied the highest position bore in virtue of his office. I am disposed to believe that *Brennus* is a Gaelic word; and that in it we have a faithful if not an unmistakable reproduction of *Breitheanas*, or *Judgment*, or better still, *Breith a nuas*, *Judgment from above*. The presence in Gaelic annals of *Vergobretus*, or *Fear gu breith*, or *Man of Judgment*, or judicial officer, strengthens the conjecture that Brennus is a reproduction of our Gaelic word *Breitheanas*.

Various opinions have been advanced as to what the true meaning of the term *Celt* is. In his introduction to the "Beauties of Gaelic Poetry" Mackenzie writes: "The appropriate name which this remarkable people gave themselves was *Celtae*, but the terms *Calatae*, *Galatae* or *Gallatians*, and *Galli* or *Gaul*, were adopted by the Greeks and Romans, and were the appellations by which in later ages they were usually distinguished. A more probable derivation is from the fair complexion by which the ancients characterized this race. This is the *Etymon* given by Greek scholars, as if the body were *Galactoi*, milky-coloured. And as G and C are commutable letters, it must be confessed that the Gaelic *Gaelta* or *Celta* has the closest possible resemblance to *Celta*." Zeuss, the erudite author of the *Grammatica Celtica*, suggests that *Gael* has its origin in a word meaning *wind*; and that it, therefore, signifies a violent, stormy people. Latham contends that *Kelt* means *Mountaineer*. In the description which Virgil has given of the various scenes that were represented on the shield of Aeneas, reference is made to the Gauls who captured Rome, "*Aurea Caesaris ollis et aurea vestis*." Two allusions are found in Herodotus to the Celts. His words, literally rendered, are these: "For the River Danube, beginning from the Kelts, and the City of Pyrene, flows, dividing the middle of Europe. But the Celts, or *Keltoi*, are outside the pillars of Hercules, and border on the Cynesii, who are the last that dwell toward the west of those who reside in Europe. The *Ister*, or Danube, beginning from the Celts, *i.e.*, having its source at the country of the Celts, flows through the whole of Europe. The Celts are the last of the Europeans after the Cynesii, who live in the direction of the setting of the sun." Pausanias thus writes in reference to the Celts of his own time: "The custom of calling them *Galatae* or *Gauls* has only prevailed of late. They were formerly named *Celtae*, both by themselves and others." We may conclude with at least a large measure of reason, that the words *Keltoi*, *Galatai*, *Gaul* and *Gael* have very much in common, and that their signification is to a large extent the same. *Kelt* is a more ancient, and doubtless a more comprehensive term than *Gaidheal*. So strong and palpable is the relation which *Gael* bears to *geal* (white) that there is valid ground for believing, in consideration of the argument which Mackenzie adduces, as well as of the reference which is found in Virgil to the yellow or golden hair of the Gaul, that the origin of the appellation, *Celt* or *Gael*, is to be traced to the fair complexion of the ancient members of the Celtic race.

The earliest settlers of a country are wont to leave behind them indelible reminiscences in the names of mountains, streams and lochs. There can be no doubt whatever that the word *Alp* is Celtic: and that we have in the very name of one of the largest mountain ranges of Europe, an enduring proof that the *Keltoi*, at some time in the remote past, inhabited that portion of Europe which is embraced by the region of the Alps. There is an old Gaelic word *Alp*, which signifies a height or

mountain, and hence we perceive that *Alp* is a very expressive designation. In the word *Apennines* the root *ben* or *beann*, a hill or mountain, occurs; nor can there be any difficulty in detecting a strong likeness, if not an identity, between the name of the mountain range in Italy and *Apuinn*, the name of a hilly district in the north of *Argyllshire*. *Pyrenees* (*bryn*, a hill), the name of the range of mountains whereby Spain is separated from France, is a compound of *bior*, sharp, and *beinn*, *Biorbheinn*, sharp-pointed hills. When it is remembered that the letters *b* and *p* are convertible in Gaelic, the similarity of the Gaelic word, *Bior-bheinn*, *piorbheinn*, and *Pyrenees* will become apparent. The Gaelic word *Tabh* (water) is to be found in *Loch Tay* and the *River Tay* in *Perthshire*, Scotland. There can be no doubt that the same root, *Tabh* (Irish *Tab*), is traceable in the word *Tiber*, *Tagus*, *Thames*. It is said that when the Roman soldiers beheld the *Tay* in *Perthshire* they exclaimed, *Ecce Tiberim*. I find that *Tacitus* in his "*Agricola*" renders *Tay* by *Taus*; and, such being the case, it is evident that *Taus* and *Tagus* are largely identical, and that in the name of the latter river we have a Gaelic word which signifies water or ocean. In the word *Italy* the presence of a Gaelic word is traceable. *Eudail*, the Gaelic name of that country, involving, as it does, *Eudail*, cattle, does not bear a very far-fetched resemblance to *Italy*, and indicates that the fertility of that country has always been very great. Very few suspect that *Portugal* is a genuine Gaelic word—*Port nan Gaidheal*, the port or harbour of the Gaels. In *Oporto*, the presence of the same word *port* is to be found. The very fact that the harbour which *Columba* entered when he first visited *Iona* bears to this day the designation of *Port va Curaich*, is sufficient to show that *port* is a genuine Gaelic word; and that its presence in *Portugal* justifies us in sending our thoughts back to a time when Gaelic was spoken in that country.

The names of some of the rivers of France are Gaelic. *Rhine* is compounded of *reidh*, smooth, and *amhainn*, river. *Rhone* is compounded of *ruadh* and *amhainn*, the Red river. *Garonne* is compounded of *garbh*, rough, and *amhainn*, river, the rough river. *Seine* is compounded of *seimh*, smooth, and *amhainn*, river, the smooth river. In *Calais* we have almost an exact reproduction of *Caolas*, a Gaelic word, which signifies *Firth* or *Strait*. The narrowest part of the English Channel is at *Calais*. In *Baile Chaolais*, a little village at the mouth of the famous *Pass of Glencoe*, in the north of *Argyllshire*, a word which in its English form, *Balachulish*, baffles the skill of the English tourist so far as pronouncing it correctly is concerned, we have the word *Caolas*, the farm or village of the strait. Thousands who are in the habit of admiring the sublime scenery of the *Kyles of Bute* in the *Frith of Clyde*, are not aware that *Kyles* is exactly the Gaelic word *Caoil* in its plural form, and, therefore, signifying *straits* or *narrows*. In *Colintraive*, or *Caol un t-snaimh*, the *strait of swimming*, we have another word into which the root of *Calais* enters as a component part. *Dover*, which stands opposite *Calais* on the other side of the English Channel, is the Gaelic *Dobhar*, a word which means the border of a country. The examples which have now been given of names of mountains and countries and rivers wherein Gaelic roots are manifestly present, may suffice to indicate that the Celts inhabited the south and south-west of Europe in the far-off past, and that they left monuments behind them in the names of mountains, streams and rivers—monuments which no power of victorious armies can ever demolish—monuments which will continue to endure and to tell in their own mute language that the Celts once owned and occupied that portion of the world.

Many questions may be asked in connection with the Gaelic words, *Calais* and *Dover*. Is it not clear that the Celts in those far-off days were well aware that the narrowest channel is between *Calais* and *Dover*? Is not the surmise reasonable, that they availed themselves of that particular part of the channel for going to Britain and for returning from it? Is there not ground for the conjecture that the largest stream of population must have entered Britain through the straits between *Calais* and *Dover*? The names *Calais* and *Dover* will always indicate that if the Celts

were not the earliest settlers in the neighbourhood of those places, they were at least powerful and important enough to leave behind them a memorial which time cannot obliterate. Aristotle is the first writer who mentions the British Isles by name. His words are : " Beyond the pillars of Hercules the ocean flows round the earth, and in it are two very large islands called British *Βρετανία λεγόμενα* Albion and Ierne lying beyond the Keltoi." While the term British is employed by Aristotle, he applies the name Albion to what is now known as England and Scotland. It is evident, therefore, that so far as the knowledge of the famous Greek extended, the portions of British Isles which are now embraced by the kingdoms of England and Scotland were regarded, it may be, as one kingdom, and bore one designation. Pliny's language is very similar to that of Aristotle : " Albion ipsi nomen fuit, cum Britanniae vocarentur omnes insulae." Stephanus of Byzantium thus writes : " Albion insula est hodie Britannia dicta ab albis rupibus quas mare abluit." Julius Caesar came much in contact with the ancient inhabitants of Britain. His description of their habits and their country is, therefore, full of interest. In his " De Bello Gallico " he informs us that " the interior of Britain is inhabited by a race said to be aboriginal—the coast by invaders from Belgium, who, having come over for the sake of spoil, have settled in the country. For money they use either copper or pieces of iron of a certain weight. Tin is found in the interior of the country, iron on the coasts, but the quantity is small. Copper is imported; the timber is of the same kind as in Gaul, except the beech and the fir. The climate is more temperate than in Gaul, the cold being less severe. By far the most civilized are the inhabitants of Cantium (or Kent). They do not differ much in their customs from the Gauls. The inhabitants of the interior do not, for the most part, sow corn, but live on milk and flesh, and clothe themselves with skins. All the Britons stain themselves with woad, which produces a blue colour, and gives them a more formidable appearance in battle. They wear their hair long, and shave every part of the body except the head and the upper lips. The Druids are engaged in matters of religion, and have the care of public and private sacrifices. They are the arbiters in almost all disputes, public and private, and assign rewards and punishments. Whoever refuses to abide by their decision is excluded from the sacrifices, and thereby put outside the pale of the law. The Druids are exempt from military service and from the payment of taxes. Their chief doctrine is that souls do not perish with their bodies, but are transferred after death to other bodies."

In his life of Agricola, Tacitus details the fortunes of the Romans in Britain. He particularly describes the exploits of his father-in-law in Caledonia and against the Gaels whom Galgacus led. The speech which, following the example of classic historians, he puts into the mouth of Galgacus, is remarkable for the patriotic spirit that pervades it, as well as for the ingenious argument which the brave Gael adduces to stir up the hearts and stimulate the heroism of his soldiers. It was at the Grampians that the battle was fought between Agricola and Galgacus. The army of the Gaelic warrior was defeated, and found instant refuge in the rocky portions of Caledonia. May we not discern something akin to the division into clans which subsequently prevailed in the Highlands of Scotland in these expressive words of the Roman historian : " Nec aliud adversus validissimas gentes pro nobis utilius quam quod in Commune non consulunt." The name Galgacus is evidently Gaelic. It is virtually Gaidheal gagach, a stammering Gael—a Gael with an impediment in his speech. Enthusiastic descendants of the heroes who fought under Galgacus are wont to reflect with pride that, while the Roman arms were powerful in every corner of the world, and while the bravest races were compelled at last to succumb to the forces of the city on the seven hills, the Caledonians were never fully vanquished. It defied the forces of Rome and her ablest generals to bring under her yoke the intrepid inhabitants of Caledonia. I am disposed to think that into the term Grampians there enters the adjective *gorm* or *garbh*, and beinn, *gorm bheinn*, or *garbh bheinn*, green mountains or rugged mountains.

Many ethnological questions suggest themselves—questions as to how Great Britain and Ireland were first settled; as to what course the stream or streams of population took; as to whether there had been two streams that entered Britain from the continent of Europe, or whether it is possible to maintain that the differences which have existed for many centuries between what Zeuss chooses to term the Irish and British branches of the Kelts in Great Britain and Ireland—arose after the Celts had fairly taken possession of the British Isles. Scholars who have examined the question very carefully are disposed to believe that the differences which now exist between the representatives of the ancient Celts began and were developed in the British Isles, and are necessarily to be regarded as the result of two independent streams of population from the continent of Europe. Latham avers that, "no matter how unlike the Scotch and the Welsh may be, they are more like than the English that lie between them." It is altogether probable, according to a reasonable conjecture, that the route of which the earliest Celts availed themselves was the straits between Calais and Dover. The earliest settlers would extend northwards and westwards, reaching Scotland, and advancing to that portion of it which was subsequently known as Caledonia. As to the manner in which Ireland was peopled, for poetical legends are fanciful, it is natural to suppose that when the western portion of Wales was reached adventurous Celts would cross to Ireland; and that, when the stream of population had fairly reached and taken possession of Scotland, so great and marked are the facilities which the south and west of that country offer for crossing to Ireland, that Celts could in a very simple manner plant homes in that island. Owing to the rude interference of the Romans, and to the prowess of their arms, as well as on account of continuous invasions in later centuries from the north and west of Europe, the Britons or the early occupants of Great Britain found shelter in the mountainous regions of the country. In this manner we can understand how Wales and the Highlands of Scotland came to be inhabited strictly by Celts, and to furnish a home even to our own time for the descendants of the early occupants of the British Isles.

It has already appeared, on the authority of Aristotle and others, that Albion was at one time the name of what is now known as Great Britain, or as England and Scotland. The term *Albion* is now entirely confined to Scotland. We are wont to say: I am a Scotchman, *Is Albannach mise*. I am a Highland Scotchman, *Is Gaidheal Albannach mise*. I was born in Scotland, *Rugadh mi ann an Albainn*. He is an Englishman, *Is e Sasunnach a tha ann*. He was born in England, *Rugadh e ann an Sasunn*. There is no Gaelic word to represent England or Englishmen directly. We are wont to speak of England as *Sasunn*, or the land of the Saxons, and of Englishmen as Saxons, *Sasunnaich*. It seems to me that as the word *Albion*, which at one time was an appellation for Great Britain, has for many centuries been restricted to Scotland, we may find an argument in favour of the supposition that the Highlanders or the Gaels of Scotland are the descendants of the earliest Celts who occupied Britain; that they, therefore, continue to speak of themselves as *Albannaich*, a designation which must at one time have been general enough to include all the Celts of the British Isles, and that the Britons are a later stream of population than the Scottish Gaels.

Albion signifies the land or country of hills or mountains. *Alb* or *Alp* is the same root which is to be found in *Alps*. *Albion* is compounded of *Alb* or *Alp*, for *b* and *p* are convertible letters, and *fonn*, or with the aspirate *fhonn*, *Alb-fhonn*. The root *fonn* or *fhonn* occurs in *Eilean*, *eil fhonn*, another land. *Eilean* is the Gaelic name for island. The same word, *fonn* or *fhonn*, occurs in *Oban*, a term which strictly means the land of bays or creeks, an apt designation, as anyone will admit who has seen Oban in Argyllshire, and who has taken notice of the physical features of that bay and its neighbourhood. The same root, *fonn* or *fhonn*, is to be found in *Sasunn*, England, the land of the Saxons, and in *Eirinn*, Ireland. The derivation of *Albion* (*ab albis rupibus*) from the white rocks of Britain is not to be regarded with

any serious attention. The common derivation which is assigned to *Eirinn* (Ireland) is *I iar-fhonn*, the land of the western isle; or, the land of the island of the west. The letter I (island) occurs in Iona, Islay and many other topographical names. Max Müller gives in a footnote in his first series of lectures on the Science of Language, a very learned and elaborate disquisition by an eminent Irish scholar on the etymology of the word *Eirinn*. The most enthusiastic admirer of the Celtic race can scarcely maintain that the Celts of those far-off times had even an approximation to the philosophical ingenuity that is involved in the disquisition on the word *Eirinn*, to which allusion has just been made. I hold the opinion that the common explanation of *Eirinn* is correct, and that the disquisition to which Max Müller has given a place in his lectures is too learned to be of any practical value.

Various derivations of the word *Breatunn* have been advanced. *Is Breatunnach mise*, I am a Briton. *Rugadh mise ann am Breatunn*, I was born in Britain. *Breatunn* and *Breatunnach* are, therefore, Gaelic words, and are very commonly employed. Some one has contended that *Breatunn* is a compound of *brait*, extensive, and *in*, an island; and that, therefore, the signification accordingly is an extensive island. The presence of a fertile imagination is so unmistakably manifest in that interpretation of *Breatunn* that no importance can be attached to it. An ingenious explanation of *Breatunn* has been given by Mr. Clark in his "Caledonian Bards," where he contends that the components of the word in question are *Braigh*, top, and *tonn*, waves. The argument whereby it is sought to defend that interpretation is very ingenious: "That Britain was at first peopled from the opposite coast of Gaul is a rational hypothesis, and accordingly it has been adopted by the most eminent historians. As Britain was within sight of Gaul, the inhabitants would bestow on it some name before they crossed the channel, is a supposition not altogether improbable. Ingenuity could certainly suggest no term more significant of the appearance of Britain from France, viewing it over the convexity which the globe forms in the breadth of some part of the channel, than the *land on the top of the waves*." To overthrow the fanciful interpretation that Britain means the *land on the top of the waves*, it is sufficient to consider that there is no syllable to correspond with *land* in *Breatunn*; and that in the last syllable *unn* there is evidently present the same root which forms the termination of *Albion*, *Eirinn*, *Sasunn*. The word *Breatunn* has also been resolved into *Breac Innis*, the variegated island. I find that Prydain is the name of the first legendary King of Britain, and that from him the British Isles have taken the appellation, *Ynis Prydain*. To contend that *Breatunn* had its origin in Breton, the name of that portion of Gaul from which the Celts emigrated to Great Britain, is merely to thrust the difficulty aside, and not to explain it at all. Professor Rhys, of Oxford, has in recent years advanced another interpretation of *Breatunn*. He asserts that when the Romans came to Britain they learned the name Britannia or Brettann, which the Brythones gave themselves. He is of opinion that *Britanni* and *Brettani* are regarded as of the same origin as the Welsh *brith*, spotted, parti-coloured—feminine *braith*; and that there can be found in them a reference to the painting or tattooing the body, already alluded to more than once. "It would appear," he writes, "that the word *Brythan* and its congeners mean a clothed or cloth-clad people. There is no reason why the name should not be treated as exclusively belonging in Britain to the non-Goidelic branch of the Celts of the second invasion. But some time later, there arrived another Celtic people with another Celtic language, which was probably, to all intents and purposes, the same as that of the Gaul. These later invaders called themselves Brittones, and seized on the best portions of Britain, driving the Goidelic Celts before them to the west and north of the island." It seems, however, to be impossible to explain the term *Breatunn* in a manner that can be regarded as altogether satisfactory.

The Picts and Scots are by common consent admitted to have played a prominent and restless part in the early annals of Great Britain. In a paper which I prepared for the Canadian Institute last session, I entered somewhat fully into the

discussion of the question as to who the Picts and Scots were. In his dissertation on the poems of Ossian, MacPherson remarks that the Caledonians, who possessed the east coast of Scotland, applied themselves to the raising of corn or to agriculture. It was from that employment that the Gaelic name of Picts proceeded, for they are called *Cruithnich*, i.e., the wheat or corn-eaters. I may add that the etymology of *Cruithnich* is identical with that of *Cruithneachd*, the Gaelic word for wheat; *cruth*, form, and *sneachd*, snow, the reference doubtless being to the white colour of the flour which is extracted from wheat.

With regard to the term *Caledonia*, it has to be observed that it was never applied by the Gaels of Scotland to their own country; and that it comprised that portion of country which lies to the north of the Forth. Dunkeld, in Perthshire, has been regarded as the capital of the Caledonian Gaels when the Romans first invaded that portion of Scotland. Dunkeld, or Duncalden, forms the substratum of Caledonia. Among the various explanations which have been given of Caledonia, the most plausible seems to be *Dun a' Chaltuinn*, the hillock of the hazel, and not *Dun Cael-dhaoine*, the stronghold of the Gaelic people. St. Columba is said to have resided at Dunkeld for some time about 570 A.D. There rose then at Dunkeld a royal monastery, which subsequently attained to great eminence.

Zeuss prefers to divide the Celtic tribes and languages of Great Britain and Ireland into the Irish and British branches—the former including the Celts of Ireland, and of the Highlands of Scotland and of the Isle of Man, the latter including the Welsh and the Armoricans in Brittany. It is abundantly evident that those in whose veins the blood of Galgacus and his heroes, of Taliessin and Ossian, of Fingal and Arthur is now flowing, are honouring themselves by taking a warm interest in the language which, venerable with years and use, continues to be still spoken, and to have in many cases the vigour and persuasiveness of olden times. Max Müller affirms “that the language of England may be said to have been in succession Celtic, Saxon, Norman and English. The history of the Celtic language runs to the present day. It matters not whether it be spoken by all the inhabitants of the British Isles or by only a small minority in Wales, Ireland and Scotland. A language, so long as it is spoken by anybody, lives and has its substantive existence. The last old woman, Dorothy Pentreath, that spoke Cornish, and to whose memory it is now intended to raise a monument, represented by herself alone the ancient language of Cornwall.”

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PEABODY MUSEUM.

THE ANATOMY OF THE ORANG-OUTANG. BY A. PRIMROSE, M.B., EDIN.

(Read December 18, 1897.)

A good specimen of the animal was obtained in the Anatomical Department of the University of Toronto during the autumn of 1897. This animal, which is the chief representative of the Anthropoid Apes in Asia, is found in the islands of Borneo and Sumatra. A series of photographs were made of the creature, and by this means the external characteristics were readily studied. The shape of the cranium is very similar to the human type, but the facial region of the skull projects very prominently, so as to produce a markedly diminished facial angle. Thus the photograph taken in profile shows a projecting muzzle, which is far removed from anything of the kind found in the skull of man. The nose is short and depressed, so that the anterior nares look upwards and forwards. The forehead is high and fairly prominent, in this respect differing from the condition found in the Chimpanzee, in which the forehead is retreating; in the Orang, in fact, there are frontal eminences to some extent developed. The eyelids are wrinkled, so that a series of grooves parallel to the free margin exist in both the upper and the lower eyelid. The eyes are never widely open in the Orang. From the margin of the lid project well developed eyelashes. The lips are very wide, and possess a great degree of mobility: the degree of mobility may be appreciated even in the dead animal when one separates the lips and exposes the jaw arches. The dental formula is similar to that of man—in this specimen a noticeable feature was the width and flatness of the central incisors. There is no prominence in the region of the chin. There is a very gradual curve extending from the free margin of the lower lip and merging below into the outline of the neck. The ear of the Orang and the Chimpanzee is said to be curiously like man; this statement is borne out in the present instance. The ear stands out fairly prominently from the side of the head, but not more so than in many men. Along the edge of the infolded margin of the ear, near its upper part, there exists in man a blunt-pointed process, to which Darwin has called attention, and which is supposed to represent that part of the ear which exists in many monkeys as an upper pointed extremity without any infolding. We find that a well marked process representing Darwin's point is present in this Orang. There is no lobule; it is entirely absent. In man the lobule is very frequently absent also. The Orang possesses a short, thick neck, of great strength. Lastly, in connection with the head of this animal one must note the absence of any wrinkles in the forehead. In man the wrinkling of the forehead forms one of the most characteristic forms of expression, but we find no trace of such in this Orang. The fact that this form of expression is not possessed by the Orang has been noticed by various observers.

The long arms of the Orang, reaching below the knees, and the comparatively short lower extremities, are noticeable features of the animal. In this respect it differs from man, in whom the lower extremities exceed the upper extremities in length and are much more strongly developed, thus serving more efficiently as a basis of support in the erect attitude. It must be remarked, however, that this remarkable elongation of the upper extremities in apes is also reproduced in many negroes, and occasionally in Europeans.

In an address delivered at the recent meeting of the Anthropological Section of the British Association, in Toronto, Sir William Turner selected as his subject "Some Distinctive Characters of Human Structure." Among other things he

referred to the markings which are found in the integument in the palm of the hand and the sole of the foot. I have made photographs of the palm and the sole in the Orang, and these well illustrate the conditions found as described by Prof. Turner in the Anthropoid Apes. The two oblique lines which run from the base of the index finger to the inner side of the palm in the human hand indicate the lines along which the fingers are bent in towards the palm. The obliquity of these lines in man is in contrast to the transverse direction of the lines as shown in the photographs of the Orang. It is quite obvious that the oblique direction in man indicates that the fingers are more directly opposed to the thumb in man than is the case in the Ape. Thus, in the Orang, the fingers are folded more directly into the palm, as would be the case if the animal were grasping a cylindrical object, hence transverse lines result and the fingers are not to any appreciable extent opposed to the thumb, which, by the way, is a very rudimentary structure in the anthropoid apes as compared with the thumb of man. This rudimentary thumb in the Orang, is, however, capable of opposition, and therefore we find that the deep groove which is found separating the eminence at the root of the thumb in man is also found in the Orang. In the Orang we find, too, that there is a well marked groove marking off an eminence at the root of the little finger. When we come to examine the sole of the foot in the Orang we find here a very characteristic condition. A well-marked line is developed at the root of the great toe, indicating the line along which the great toe is opposed to the other toes. This is a characteristic not possessed by man, in whom the great toe is not capable of opposition and in whom this mark is entirely absent. Further, the lines at the roots of the toes are in reality more oblique in the foot of the Orang than in the hand of the same animal. This would indicate that the foot is better adapted for grasping objects than the hand, and that opposition of the smaller toes to the great toe is more perfect than is the similar movement of opposition in the hand. In the foot of the Orang, further is to be noted the great length of the toes, producing a marked resemblance to a hand. The great toe is very much shorter than the remaining digits, but it is strongly developed otherwise and is much more effective as a grasping agent than the corresponding digit in the hand. This foot of the Ape so much resembles a hand that it has been called a foot-hand; the term "pedimanous" has been used to describe the condition. When we come to examine the structure of the foot, however, and study the bones, muscles, ligaments, etc., we find that, morphologically, we are dealing with a foot, and from that standpoint it is in no sense a hand. Physiologically, however, it performs the functions of a hand as well as of a foot. Turner alludes to an interesting point regarding the development of the markings on the palm, namely, that they are found in the human embryo at a very early stage of development, long before they could be accounted for by movements occurring in the hand of the embryo. This would indicate that the markings themselves were hereditary and are not simply acquired after the various movements which they indicate are brought about.

The Orang possesses a highly developed brain. In the particular animal we are describing the brain was removed and examined. The antero-posterior diameter of the brain is less in proportion to the transverse diameter than it is in man. The brain of the Orang may be described as a round-oval. The characteristic fissures and convolutions of the human brain are readily distinguished in the Orang. The external occipital fissure is much longer than in man. This is so characteristic of the brain of apes that it is known as the "Simian Fissure." The Island of Reil is completely overlapped in the Orang by an operculum. The third frontal convolution—said to be characteristic of man—is certainly not well defined in the example before us. This convolution of the left side in man is the so-called "speech centre." The convolutions about the fissure of Rolando—the Motor Area—are well developed.

The abdominal viscera were examined and one noted the existence of a long, well developed vermiform appendix. This structure is present in the Orang and the Chimpanzee among Anthropoid Apes, but is generally absent in Monkeys and in the majority of Mammals. One noted also the entire absence of those reduplications of the mucous membrane of the small intestine which are described in man as the "Valvulae Conniventes."

The author of this paper proposes to make a complete dissection of the Orang, and hopes to make a further communication to the Institute when the work is complete.

THE TRANSPORTATION QUESTION. BY J. S. WILLISON, ESQ.

(Read April 16, 1898.)

I.

A discussion of the transportation problem in the language of hysterical Populism unfits the public mind for a sane judgment and drives Legislatures and Parliaments to attempt legislation so rash, extreme and impracticable that rational reform is embarrassed, disastrous reaction invited and the public authority discredited. Too often that class of vociferous patriots who move against the railway corporations with a fleet of froth and an army of adjectives accomplish no other result than to inflame the public temper, disturb legitimate private investments and hurt the national credit. Always in the field of economics the forces of order are "turning to scorn with lips divine the falsehood of extremes." Indiscriminate denunciation is the vice of the press and the pastime of democracies. We in Canada, in recent days, have had much hearty denunciation of railway monopoly, and corporation-baiting threatens to become the chief business of some of our influential journals and of an active and aggressive wing of our politicians. It is beyond doubt that we have made grave mistakes in railway policy. We have been cheated by the phantom of railway competition. We have unwisely duplicated pioneer lines. We have rashly vested great tracts of the public heritage in railway corporations. But we are a young community, at least in range of settlement and in measure of development, and we have had great problems to solve; and it was perhaps inevitable that just as we gave noble forests of timber to the fire in clearing the virgin lands of older Canada, so we should make a prodigal use of the resources of the west in laying the lines of rail communication across the continent. Now, as to these grave follies of statesmanship and grave errors of policy, we can perhaps do nothing better than to say with Bacon: "That which is past is gone and irrevocable, and wise men have enough to do with things present and to come; therefore they do but trifle with themselves that labor in past matters."

II.

We should remember, too, that railway transportation has not been a profitable business in Canada, that millions of English capital have been sunk irretrievably in the Grand Trunk, that with the slow growth of settlement in the west only exceptional resource and exceptional enterprise could have maintained the Canadian Pacific as a going concern, and that both of our great through roads have been heavily burdened with unprofitable branches. Canada's reputation in the money markets of the world depends upon a few of its great enterprises. For half a century the spectre of the Grand Trunk has stood at the elbow of the Canadian financier and promoter on the London money market, and all over this country there are idle mines, and untilled acres, and rich fields of natural wealth undeveloped that would have been opened and occupied by the strong arm of British capital if the melancholy story of the Grand Trunk had not been written in financial London. If the Canadian Pacific had met a like fate, a blow would have been dealt us from which we could not have recovered for a generation. We can imagine what a blow would be dealt at the private and public credit of the United States if half the railway system of the Republic were to be plunged into bankruptcy, and when we face the fact that the Canadian Pacific system embraces half the railway

mileage of Canada, it is manifest that the maintenance of its credit is of vital importance to the Canadian people. The improving credit of the Grand Trunk and the established credit of the Canadian Pacific are facts of great consequence to Canada among the nations who supply capital for the development and men for the settlement of new lands; and while we do right to be jealous for the authority of this free community over its carrying corporations, we should be slow to work ourselves into the passionate temper of western Populism, and thereby check the movement of capital from the uneasy centres of the United States into the undeveloped Canadian Provinces. Capital is mobile. It will not rest where it is constantly menaced by political agitation. It will not seek investment where political conditions are unstable, and established enterprises harassed by revolutionary political experiments. The best service we can do for Canada is to introduce into our public controversies and to incorporate into our code of laws the prudence, the sanity, the steadiness of the British political temper and the sober courage and inflexible justice of British legislation.

III.

One lesson that a democracy finds hard to learn is that legislation cannot be made omnipotent. In Great Britain, more than in any other country, the practical limitations of Parliamentary authority are understood and appreciated. There, after fruitful centuries of trial and experiment in all the fields of coercive legislation, from statutes fixing the wages of laborers and the prices of goods at wholesale and retail, to statutes declaring the value of money and restraining the freedom of trade, private employments are at length safe from the British legislator, while over public employments the authority of Parliament is absolute and unquestioned. Railways operate in the field of public employments, exercise rights of expropriation and hold public franchises, and therefore the inferiority of the carrying corporations to the sovereign authority of Parliament is established and the right of regulation and control freely asserted. In truth, the authority of the people over transportation agencies is well settled in all free countries, and argument upon that point may rest. Having settled that these powers are vested in Parliament, the question is, through what machinery they can best be exercised. The Railway Committee of the Privy Council at Ottawa has large powers, but these have been but feebly employed for the protection of the public interest, and the technical defences of skilled counsel and the active zeal of equally skilled lobbyists make its procedure tedious and complicate its judgments with political considerations. Then the dealer, who may be prejudiced by discriminatory favors to a competitor; the farmer, whose safety may be imperilled by a dangerous crossing; the town or village, whose progress may be checked by the concession of lower freight charges to a rival community; the carrier that may be refused reasonable interchange of traffic by a competitor—each and all of these have found the Railway Committee inadequate to give satisfactory redress. The individual citizen, aggrieved by railway greed or vindictive discrimination, cannot go to the capital and lay his grievance before the committee. The cost is too great, the undertaking too onerous. He requires the privilege of communicating his complaint to a public commissioner, and upon the commissioner should rest the responsibility of investigating the complaint and redressing the injustice. The commission must operate through methods of conciliation as well as through methods of compulsion. There is no doubt that in many cases the American advisory commissions, that is, the commissions with power only to report the facts and leave to public opinion, either acting directly on the railway corporations or through the Legislature, the remedy for the evils established, have been influential in redressing the more flagrant discriminations and injustices of railway managers, and in Massachusetts, for example, it has not been thought necessary to adopt more drastic legislation. But at most the power

of the advisory commissions is no greater than the force of public opinion and public opinion is likely to be inactive, except during seasons when the transportation question is a main issue in the press or in politics, or some very special grievance looms large in the public eye.

IV.

It is a common notion that in Great Britain the railways are effectually controlled by the Board of Commissioners created in 1873, and vested with the powers of jurisdiction exercised by the Court of Common Pleas under the old law (Act of 1854). Mr. Stickney, in his new book on State Control of Trade and Commerce, declares that this Act is "amply sufficient to redress any substantial injuries done by common carriers to the public," and that in the field of private employments the growth of the law "has been from a condition of minute and annoying restriction to one of complete freedom," while in the case of public carriers it "has been from a condition of comparative freedom to one of complete and adequate supervision and control." This conclusion will not bear investigation. It was the judgment that I had reached from a study of the American books dealing with the railway question, but even a perfunctory and inadequate study of the question on the ground made it plain that the laws regulating common carriers are not as well enforced in Great Britain as in the United States. The great British railway corporations have enormous political and commercial power. There are now 140 railway directors in the Imperial Parliament. The British railways support the Parliamentary bar, they control influential organs of financial opinion, they keep a strong hand upon the course of legislation, and they discriminate against the domestic in favor of the foreign shipper to a degree that is intolerable. It seems to be the fact that grain and other food products are carried from Calcutta or from New York to London for rates much lower than are charged on similar home products from mid-England into the metropolis. The British agriculturist suffers almost as seriously from railway discrimination as from hereditary landlordism, and German and Belgian and American competition with British manufacturers is greatly aggravated and materially promoted by the secret discriminations and lower rates made for foreign competitors with British industries.

V.

There is combination to maintain domestic rates and open or secret competition for the carriage of foreign goods. This, in fact, seems to be a feature of railway administration the world over. The policy of the railway managers everywhere is to enforce the maximum rate on home traffic, and to compete for foreign shipments at any rate that may be necessary to secure the business. The subsidized railways of Canada carry American goods at rates so much lower than the charges exacted upon native products that in many cases the discrimination more than offsets the advantages of the Canadian tariff. No doubt the result of this policy is to increase the bulk earnings of the Canadian roads, and, it may be argued, enables the companies to reduce the average of transportation charges. But the inevitable tendency is to build up foreign rather than Canadian ports and foreign rather than home industries, and to unduly burden local traffic in the interest of through business. As between Germany or Belgium and Great Britain the effect is peculiarly and particularly objectionable. The German and Belgian railroads are owned and operated by the State. There are, therefore, no secret rates or discriminations on the German and Belgian roads, and the embargo which British railways put upon British trade is unknown within Germany and Belgium, and the British manufacturer enjoys no such advantages in the German or Belgian market as the German or Belgian manufacturer and trader enjoy in the market of Great Britain.

But the British people are moving. Some of the younger British politicians have been making a close study of the State railways of the continent; there is unrest among the agricultural population, and manufacturers are awakening to the injustice of these intolerable discriminations in favor of their foreign competitors. And once the British people are thoroughly roused to the existence of an injustice, reform comes speedily and thoroughly. It may be that for the moment the British people would not consider State ownership, but we must remember that they have taken over the telegraph service, that that service is operated as efficiently as the postal service, and it is at least my conviction that before the world is much older we shall have in Great Britain a formidable movement for State ownership of the carrying corporations, and that public ownership rather than public regulation will be the future railway policy of England. More than half a century ago, as far back as 1844, Mr. Gladstone put through the British Parliament a measure, to take effect 21 years thereafter, declaring the right of the State to take over the railways at such time as the people might determine to be propitious and advantageous, and that the price should be 25 years' purchase of the "annual divisible profits estimated on the average of the three then next preceding years;" and it is a noteworthy fact that, notwithstanding this Act, some of the ablest advocates of State railways in Great Britain counsel delay on the ground that the railway corporations have such vast political power that they would force Parliament to pay for their roads a price far in excess of their actual value.

VI.

Mr. Clement Edwards, in his new work on Railway Nationalization, makes an interesting estimate of the possible financial results of State purchase of the British railways. The profits of the British roads are put at £38,046,065, or 4 per cent. on the capital invested. He believes that the State railway stock would be taken up at 2 1-2 per cent. as a maximum. This would leave a margin of nearly 1 1-2 per cent. on the transaction. He estimates saving by unity of management at £10,000,000. Thus he would increase the profits from £38,000,000 to £48,000,000, and after deducting 2 1-2 per cent., £23,775,000, to cover the interest on the Government railway stock, he would get a net profit to the State of over £24,000,000. He would thus be enabled to reduce freight rates by 20 per cent., absorbing £8,807,000, reduce passenger fares by 20 per cent., absorbing £7,472,000, and use £4,000,000 to reduce hours of labor and improve wages, and still have nearly £4,000,000 to provide for a sinking fund and exceptional contingencies. Mr. Edwards adds: "The recoupment from increased traffic could be used for still further reducing rates and fares, and augmenting the sinking fund to facilitate redemption of purchase, remembering always, however, that the lower the rates and fares are reduced to a certain point, the greater the traffic, and the better for the nation." This is an optimistic calculation, but in sober truth it seems to be warranted by the experience of State operation of railways on the continent.

VII.

A remarkable illustration of the effect of cheap fares on passenger traffic is afforded by the introduction of the zone system in Austria and Hungary. In these countries, under this system, one may travel first-class by fast express at a penny and a third a mile, and third-class at less than a half-penny a mile. In Hungary, for the four years from 1889 to 1892, the number of passengers carried increased from 5,684,845 to 38,325,151, and in Austria, for the six years from 1889 to 1894, the increase in the number of passengers ran up from 42,582,726 to 102,897,828, an increase of 600 per cent. in Hungary and of 140 per cent. in Austria, as compared with 11 per cent. increase in Great Britain. Then, while the Hungarian railways were

paying 3.48 per cent., when the zone system was adopted they paid 6 per cent. in 1892, and while in '89 the Austrian railways paid 4.01 per cent., in '94 they paid 4.08 per cent. It is quite likely that in Great Britain the zone system and cheap fares would yield as good results, and possibly in the United States and Canada the results would be hardly less satisfactory. The main fault to be found with passenger rates on this continent is that they are made to carry a great percentage of deadheads, and of the very class who are best able to travel at their own expense. If this mortuary department were abolished there is little doubt that the Canadian railways could give a two-cent rate without impairment of revenue, even if but a very moderate increase of passenger traffic were secured.

VIII.

The United States has a better railway literature, a greater body of railway legislation, and has made, at least in some of the States, a more determined attempt to regulate and control the carrying corporations than any other country. The results have not been wholly satisfactory. The operation of the laws has been embarrassed by a conflict of jurisdiction, the half-heartedness of Legislatures, and the hostility, or at least the unsympathetic attitude, of the courts. Only such traffic as originates and terminates within a State is subject to the State Commissions, while the authority of the Interstate Commission is limited to interstate traffic. This condition requires concurrent action between the State and Interstate Commissions, creates confusion, gives occasion for technical disputes, necessitates a divided sovereignty, and blocks and complicates the work of the commissions. Still much has been accomplished, particularly by the strong State Commissions, and the work of the Interstate Board has been by no means unfruitful or ineffective. In *The Atlantic Monthly* for April there is an admirable review of the work of the Federal Railway Commission since its creation in 1877. The writer, Mr. H. C. Adams, is the statistician of the Interstate Commerce Board, and ranks high among the authorities on the subject. He tells us that the idea of the commission was that "authoritative principles of railway transportation should be developed very much as legal principles attain their growth," that to this end it was necessary that a large variety of cases of discrimination and unjust rates should be considered, and that in some way this result must be realized if the control of railways through commissions is to prove a permanent part of the political organization, and he argues that "had the courts been willing to grant the commission the interpretation that Congress assured for it when it was passed, the railway problem would by this time have approached more nearly its final solution." Notwithstanding this, however, there has been a marked movement toward uniformity in administration, a useful service of statistics has been developed, and a far step has been taken toward a uniform system of railway accounts. He points out that "if there be but one system of accounts for all corporations subject to the jurisdiction of the commission, it is necessary only to master the principles, rules and classifications of one system in order to gain a mastery of all," and he declares that "out of the opinions expressed upon cases there has begun to develop a system of authoritative rules and established interpretations, which, sooner or later, will come to be recognized as a body of administrative law for inland transportation."

IX.

Mr. Adams gives this compact statement of the main conclusions that have been reached by the commission:

"It has been decided that a just schedule of rates will not tend to destroy the natural advantages for the production and sale of goods possessed by localities;

and when the same commodity is transported by two or more different modes of carriage the charge should be uniform for the unit of commodity.

"Group rates," by which a given commodity produced at different points within a prescribed territory is rated as though shipped from a single point, do not constitute a discrimination repugnant to the law; but this opinion is limited to the cases presented and is not set forth as a general principle.

"A rate on one commodity in a class, or on one class of commodities, cannot be justly depressed so as to become a burden on the transportation of other commodities or classes of commodities.

"The law does not impose upon the carrier the duty of providing such a rate that goods may be sold at a profit to their producers.

"The car-load, and not the train-load, is the proper transportation unit, but higher charges may be made for goods in less than car-load lots; with this exception, the decisions of the commission have been consistently against the application of the 'wholesale' principle in the adjustment of railway charges."

"Not only must a just schedule of rates rest on a just base, but the relative rates on competitive articles must be such as not to disturb the natural order of competition.

"A just schedule of rates will conform to the competitive equities that exist between goods shipped at different stages in the process of their manufacture.

"All shippers should have at their disposal equal facilities of transportation; but in judging of local advantages, care must be taken not to confound those that are artificial with those that are natural.

X.

It has to be added that the experience of the United States has established beyond controversy that, in order to the successful operation of railway commissions authority must be granted to compel witnesses to testify, that the investigations of a commission must be final on matters of fact, that an order of the commission must be enforced unless the courts shall find some material error in its proceeding and judgment, and that a commission must have the right to prescribe a reasonable rate, as well as to declare that a rate fixed by a carrier is unreasonable. The closing words of Mr. Adams' sane and moderate paper are well worth quoting. He says: "The record of the Interstate Commerce Commission during the past ten years, as it bears upon the theory of public control over monopolistic industries through the agency of commissions, cannot be accepted as in any sense final. It may ultimately prove to be the case, as Ulrich declares, that there is no compromise between public ownership and management on the one hand and private ownership and management on the other; but one has no right to quote the ten years' experience of the Interstate Commerce Commission in support of such a declaration. This is true, because the law itself scarcely proceeded beyond the limit of suggesting certain principles and indicating certain processes, and Congress has not, by the amendments passed since 1887, shown much solicitude respecting the efficiency of the Act. It is true, also, because the courts have thought it necessary to deny certain authorities claimed by the commission, and again, Congress has not shown itself jealous for the dignity of the administrative body which it created. And, finally, it is true because the duty of administering the Act was imposed upon the commission without adequate provision in the way of administrative machinery, and ten years is too short a time to create that machinery, when every step is to be contested by all the processes known to corporation lawyers. For the public the case stands where it stood ten years ago. Now, as then, it is necessary to decide on the basis of theory, and in the light of political, social and industrial considerations rather than on the basis of a satisfactory test, whether the railways shall be controlled by the Government without being owned

or controlled through Governmental ownership. The danger is that the country will drift into an answer of this question without an appreciation of its tremendous significance."

XI.

The public regulation of railway rates in Canada is not beset with some of the most formidable difficulties that have embarrassed and crippled the commissions in the United States. We have practically only two great through railways, in the main they operate under very similar territorial conditions, and by the Federal Acts declaring most of the Provincial branch railways to be roads for the general advantage of Canada the Federal Parliament would seem to have authority over the entire railway system of the country. We may be sure, however, that the validity of the laws which have authorized the summary seizure of the Provincial railways will be tested when we come to establish and attempt to operate a Federal railway commission. There are three possible courses open to the Canadian people: (1) The present system of spasmodic railway competition, and enduring and unregulated railway combination; (2) regulation and control by a strong Federal commission; (3) public ownership and operation. The third is no doubt the final solution, but it is probably remote in Canada. I do not believe that it would be sound policy to attempt to regulate great through systems by building patches of Government road in various parts of the Dominion. There is, however, much to be said in favor of natural extensions of the Intercolonial and the acquirement of natural and profitable branches of the Government railway. But in the main one must have either a system of public railways or a system of private railways. For the Government to go into the business of competition with private railways would be unwise, and would mean the adoption of a policy discredited by the experience of Germany and other countries. The result would be either the ruin of the private railways and enormous deficits at Ottawa, or the public roads would simply fetch and carry for the private corporations. In the end we would have to take over the private roads or hand our Government roads over to the private concerns, and in either case we would then find the country burdened with hundreds of miles of unnecessary railway. Our best and soundest policy for the time is to create a strong railway commission, vested with power to abolish discriminations as between particular individuals and rival communities, to force a fair interchange of traffic between rival lines, and to establish some reasonable relation between local and through charges. If we can regulate by commission we can regulate without Government railways. To adopt the double method would be costly and absurd. If we can make regulation effective over the Grand Trunk and the Canadian Pacific it would be folly to create a new great through line in order to divide the traffic and increase railway charges to the farmers and traders of the country. For every mile of new railway you construct an additional charge is laid on the people for railway support, and at least in a sparsely settled country it is only by increase of traffic that material reduction of rates can be secured.

XII.

There are grave objections to the policy of subsidizing railways out of the Federal Treasury. Most of us are convinced that the system of Provincial subsidies was a mistake, although if we look far enough we shall probably agree that upon no other condition could we have induced the eastern Provinces to come into the Confederation and surrender their control over customs revenue. But the subsidies to Provinces are arbitrarily determined by growth of population and the terms of union. While in the case of Federal subsidies to local railways there is no fixed basis of distribution, localities and Provinces are not unlikely to engage in a competition for Federal favors, and in too many cases party considerations rather than

the public interest determine the distribution of the public money. We are fond of saying that railways should be undertaken purely as commercial enterprises; but with an empire to colonize, vast spaces to open in the west and enormous natural obstacles to overcome, and settlement scattered over wide leagues of prairie, it is doubtful if any practical government could conclude that liberal aid to pioneer roads or the construction of pioneer roads by the State was not a wise and legitimate feature of any well-considered plan of colonization. Theory counts for a good deal more in print than in government. We owe something to remote and struggling settlements, and if we proceed wisely we reap a return in growth of markets, expansion of trade and increase of revenue. It does seem clear, however, that we should vote no more public money to our great through systems, and that, richly and prodigally endowed as they have been out of the public treasury, they should now construct their own branches, and even as in the case of street railways, where they enjoy a monopoly in any rich territory, they should be required by Parliament to push out new branches as increase and extension of settlement demand.

XIII.

It seems for the moment to be the policy of Parliament to reserve running rights over new roads for possible competitors. It may be that this policy involves the continuation of the system of subsidies. In cases where heavy public subsidies are voted to aid in the construction of railways that become the property of private companies, it is perhaps not unreasonable that the State should reserve the right to give future competitors the privilege of running over rails that have been laid with public money. But in the case of roads that are built wholly by private capital, it would seem to be an extreme exercise of the public authority to give competitors, seeking to share in a business they had done nothing to create, the right to use the roadbed and station accommodation of the pioneer corporations. This policy was tried in England, but was found to operate as a very serious check to railway building, and was abandoned as unprofitable and impracticable. Perhaps all that can be said on the point is that it is a policy that can be applied to existing railways only by mutual agreement, and to such railways hereafter to be constructed as may receive large grants of public money. It was well in the case of the Crow's Nest Railway, where a mountain pass was to be held for the people, that this right of running powers should be clearly and unequivocally reserved, and it is fair to point out that a subsidy granted with this material reservation is something very different from a grant of aid without conditions. It is, in fact, almost equivalent to public ownership, and will give a roadbed through the mountains to any railway, private or national, that may hereafter be constructed across the western prairies into British Columbia. Perhaps a more practicable policy would be to acquire the right of way and build the roadbed of new railways with the money of the State and lease the rails to private corporations. This would be to stop midway between public ownership and operation and would make the final stage easy, and as it is not at all difficult to fix the carload rate per mile for freight business, public regulation of charges under such conditions could be made very effective. It seems to me it would be well to consider this policy in developing a railway system in northern Ontario, where as yet the claims and franchises of private corporations have only a slight foothold, if we are not ready to accept the more heroic policy of public construction and operation.

XIV.

One hardly finds it necessary to prove the waste of competition, the fact of combination, the existence of discriminations in Canada. There is for the time a war of passenger rates between the two great Canadian railways, but this will be

of short duration, and the settlement that will shortly be reached will probably be followed by a more rigid enforcement of the maximum charges for passenger traffic all over the Grand Trunk and Canadian Pacific systems. As to freight rates, there is an inflexible combination between the two great Canadian roads. One road will not give a reduced rate to a community or to a class of shippers except through consultation and agreement with its competitor. If ever secret discriminations are made they are probably granted to some great trading corporation or some great business house whose shipments are of very material consequence to the railway, and just as there is secret surrender to these powerful concerns the position of the ordinary shipper is prejudiced and business monopoly established. Live stock is carried from Chicago to Montreal for as low rates as are charged from points in western Ontario to the commercial capital. Grain is carried from Winnipeg to Fort William, 500 miles, for 17 1-2 cents per hundred, and from Fort William to Montreal, 1,500 miles, for 20 cents per hundred. On the main line of the Canadian Pacific the passenger rate between stations is five cents a mile all through British Columbia, while the through rate from older Canada to Vancouver is less than half a cent a mile. On freight shipped to Kamloops, Ashcroft and other points along the main line of the road in the interior of British Columbia the charge is the same as if the goods were shipped through to Vancouver and brought back two, three or four hundred miles to the point of destination. It has been established that a carload of self-binders is carried from Toronto to Australia for less than the through charge to the Northwest. A reduction of rates from Edmonton and points on the Calgary and Edmonton road gave new life to the Alberta district, and made all the difference between comparative comfort and a bare, hard living to hundreds of western settlers, and probably increased the traffic earnings of the railway. Great for adversity or for prosperity are the powers of railway corporations.

XV.

At the Union Station every day we have eloquent evidence of the waste of so-called competition. At the same hour each morning and night two great express trains start for the east, both perhaps half loaded, each carrying passengers at the same rate, making about the same time, and traversing very much the same territory. How much better it would be if we had one well-equipped, well-balanced, fast express service, and a well-ordered system of branch roads. What a waste of railway mileage we shall have on hand if we ever take over the private railways, and how important it is that we should not repeat the blunders of Ontario and Quebec in western Canada. But if we deny the people competition we must give efficient regulation, and even with satisfactory regulation we should keep always in view the probable final acquisition of the railways by the State, and strive so to distribute our new roads that the State shall not be required to take over thousands of miles of unnecessary and unproductive railways. It is estimated that in the United States there are 37,000 railway stations, that not more than eight per cent. of these are junction points, and therefore at nine-tenths of the shipping points of the country the shippers and buyers of goods must always be dependent on the facilities and rates offered by a single line of railway. In Great Britain there are about 6,000 railway stations and about 1,500 junction points. In Canada the ratio of possible competing points to the number of stations is certainly much less than in the United Kingdom, and probably lower even than in the United States. Our country, at least our developed country, is of unhappy geographical formation, and transportation over such enormous distances is very costly, and to create another through road to compete with the Grand Trunk and Canadian Pacific for Canadian traffic would be very like the enactment of a statute to impose a tax of 20 or 25 per cent. on all interprovincial trade. However effective we may be able to make a law for the regulation of common carriers, it is at

least beyond controversy that in competition there can be found no satisfactory solution of the railway problem, and we must look for the present to regulation by commission, and finally to public ownership and operation.

XVI.

A question of perhaps greater importance to the west than even the regulation of railways is the taxation of corporation lands. As the Minister of the Interior told Parliament the other day, we have 67,000,000 acres of land in Manitoba and the Northwest Territories reserved from settlement. "On that 67,000,000 of acres," said Mr. Sifton, "I, as the Minister of the Interior to-day, cannot give a man a homestead entry. Nor can I sell a single acre of it, although there are millions of acres of that land that never have been and never will be nor can be earned by any railway company. But they are reserved by order in Council, the good faith of the Dominion is pledged to that for ever, and no Government can interfere with that reserve until the bond is literally fulfilled to the last letter." Much of this land is held by the Canadian Pacific Railway Company, but there are also several millions of acres held by other railway corporations, and these lands, while not exempt from taxation by deliberate enactment, are not immediately taxable, because patents are not issued until the land is paid for by the purchaser from the railway. The clause in the Canadian Pacific charter under which its lands are exempt from Dominion, Provincial and municipal taxation, reads:—"The lands of the company in the North-West Territories, until they are either sold or occupied, shall also be free from such taxation for twenty years after the grant thereof from the Crown." The charter is dated February, 1881, and makes provision also for the granting of alternate sections of land on each side of the railway. Whether this exemption extends from the time the surveys are made and the lands become the property of the company, or from the issuing of the patents by the Government, is a point of first-rate importance. If the twenty-year exemption extends from the time the lands become the property of the company, the bulk of the railway reserve will soon become subject to taxation. If the exemption extends from the issue of the patents, it is, under existing conditions, perpetual. The company has its land secured and will take out the patents only as the land is bought by the settler. Under this interpretation the clause has the same effect as if it had simply declared the land free from taxation until sold or occupied. It is perhaps not too much to say that when the charter was granted to the syndicate the popular impression was that the exemption from taxation was to run for only twenty years, but a popular impression and the technical meaning of a railway statute are likely to bear a very different significance in the final analysis. One would think that it would be wise policy for the western railways to put their rates down to the very lowest figures that would yield a living revenue and thereby increase the value of their great landed estates. There is no doubt that low freight charges would do more than any other conceivable influence to promote settlement, and as settlement grows, as roads are made, schools opened, villages and towns established, the alternate blocks held by the railways rise in value, and the corporation grows steadily richer and richer through the sweat and toil of the settlers. The farmer who may have the ambition to acquire an adjoining railway section will feel that for every dollar of additional value his improvements give to his own property he adds to the value of the adjoining land which he aims to acquire, while he and his neighbors are refused even the privilege of imposing legitimate Provincial and municipal taxation upon these vacant spaces.

XVII.

This means practically a railway sovereignty and a subject population in the west, and there is no escape for the people from this unhappy condition except

through the exercise of the power of taxation. It is, therefore, of the very first consequence that the Government of Canada shall give early and close attention to the Land Question in the West, seek an authoritative decision from the courts as to when these lands become subject to taxation, if there be any doubt, and use to the full the power of Parliament to force the early issue of patents and to re-establish the authority of the people over the wide-stretching areas that we have rashly surrendered to railway corporations. We have here a question of tremendous import to the future of Canada, and we may be sure that as the seeds of irritation germinating at the roots of this problem spring into life and vigor, only by wise and patriotic handling of the situation will we be able to secure justice for the people without doing injustice to corporations that were deliberately created by the Parliament of Canada and deliberately endowed with these vast estates. But, even in the face of a problem like this, we may hope that this British community will move toward reform and readjustment in the spirit of justice and fair dealing, and not in the temper of confiscation and destruction. As yet there is no very serious indictment to lay against our railway corporations. The Grand Trunk, with all its mistakes and all its misfortunes, has done splendid service for the Canadian people, and we can afford to regard with kindly eye and sympathetic mind the labors of the Grand Trunk management to redeem the fortunes and restore the credit of that great pioneer in the carrying business in Canada. And as one passes over the great length of the Canadian Pacific road, with its thin fringe of population stretching for thousands of miles through wastes of rock, and wide reaches of sparsely-settled prairie, and great overhanging mountains and pioneer villages and scattered homesteads, he must conclude, despite all the clamor of the press and all the vehement eloquence of the politicians, that it is one of the marvels of this time, even when we take account of its great public subventions, that the road has been established in the financial centres of the world as a revenue-earning and dividend-paying property.

The Book tells us that there is "a time to get and a time to lose, a time to keep and a time to cast away," and it seems to me that now is the time for Canadians to get new inspiration and new courage, to cast away old prejudices, to rise superior to old quarrels and to seek a new and a common dedication to the work of building up in this new land a civilization that will have all the freedom without the license of the earlier western democracies, and that will have the stability of the old British constitutional system without the pomp and circumstance of privileged and governing classes. To my mind, the test of civilization is not in flags, or in fleets, or in armies, is not in dominion over leagues of land or over leagues of sea, but in the average material comfort and moral safety of the masses of the people. The hungry mouth is the great problem of modern civilization, and that country that can feed the multitude and have even twelve basketsful to spare will take the primacy among the nations. We should so direct our policy and so fashion our legislation that great fortunes will be hard of accumulation, that our corporations will be the servants rather than the masters of the people, and that equality of opportunity shall be preserved to all elements of the population. The danger to democracy comes from unequal social conditions, from the bare foot and the empty hand; and we, with all our rich natural heritage and all our wide, unoccupied lands, may still escape many of the evils of the old world and many of the follies of the new; may still make the remnant of the natural wealth of the country the possession of the whole people, reserve some fair percentage of the revenue from natural resources and natural opportunities for public uses and for the public treasury, and establish here in our own rich and spacious domains a freer and a better civilization than any the world has known. Many of us could, perhaps, do more than we are doing to maintain a sane public opinion in the country. There is nothing easier than to shriek the shibboleth of a mob. It is vastly easier to make an unjust attack on

a corporation than to make a just defence of a corporation. It takes courage to turn in the teeth of a mob or a wave of sectarian or national prejudice and strike a man's blows for one's own opinions. But, after all, the citizen who speaks his own mind, rests on his own judgment even in the face of press or caucus or pulpit, is the only free man and the only man worthy of representative institutions. A needless war against corporations is a menace to credit and a drag upon progress, but we are far more likely to surrender unduly to the corporation lobbyist and the concession hunter than to be over-vigilant for the rights of the people in public franchises and natural resources. We cannot hold for the people too much of what is left; we cannot too soon establish the right of control and of taxation over what has been surrendered. But, after all, the outlook is hopeful. We are neither oppressed nor in peril of war or famine. We live in a land of plenty and a time of peace. Within the past year or two there has been a wonderful upgrowth of Canadian feeling. Here at home we feel a new impulse to progress, a splendid confidence in ourselves, and across the old world the name of Canada is ringing as it never rang before. It is not a time to bicker and snarl as to what man or what party is responsible for these happy and hopeful circumstances and conditions. It is not a time to revive the memories of old quarrels and deliver judgment on the mistakes and follies of earlier days. Are we sure that we would have done better if we had had to bear the responsibilities of the fathers? Let us rather unite to honor all men who give us faithful public service, to recognize the good intent of all men who labor for the public betterment, and to make the splendid promise of to-day the more splendid achievement of to-morrow.

The golden fleece is at our feet,
Our hills are girt in sheen of gold,
Our golden-flower fields are sweet
With honey hives. A thousandfold
More fair our fruit on laden stem
Than 'Jordan's tow'rd Jerusalem.

THE ORIGIN OF OCEAN TIDAL SECONDARY UNDULATIONS. BY F. NAPIER
DENISON, TORONTO OBSERVATORY.

(Read April 23, 1898.)

Last year the writer had the honor of reading before the members of this Institute a short paper, entitled "A Probable Solution of the Secondary Undulations Found Upon Ocean Tidal Records." As the information then obtainable was extremely limited, the important points were set forth as suggestions for criticism. Since the publication and widespread distribution of your valuable "Proceedings" containing this paper, the writer has received numerous encouraging letters bearing upon this subject from various quarters of the globe.

In order to still further pursue this most engrossing and what is to be hoped valuable investigation, arrangements were made by Mr. Stupart, Director of our Service with the Marine Department at Ottawa, whereby the writer was granted free access to all the Canadian Tidal records now under Mr. M. W. Bell Dawson, Engineer in charge of the Tidal Survey, who also assisted me in every way possible. Tracings were made from over 1,000 daily tidal records, showing different types of undulations, from the following stations:—Halifax, Anticosti, St. Paul Island, Forteau Bay, St. John, N.B., Father Point, and Point Levis; also the original records were obtained from the temporary tidal stations at Carleton, P.Q., Pictou, N.S., Souris, P.E.I., St. Peter's Bay, P.E.I., and the Grindstone Island Barograph records from 1893-1894 to study with the corresponding Anticosti tidal traces, also tracings from several St. John, N.B., barograms. Upon returning to Toronto these records were carefully studied in conjunction with the corresponding synoptic weather charts at the Observatory. The result of this investigation clearly demonstrated that these undulations are due to the direct action of atmospheric waves or billows, as they pass over the harbours or bays, which tend to form minute undulations upon the surface of the water, and as these small water undulations advance farther into semi-enclosed basins become magnified as they reach narrower and shallower portions where the tide gauges are situated. Permit me briefly to summarize what has already been observed by others bearing upon this interesting subject.

In 1838 this phenomenon was observed at Swansea, England, where a regular time interval of from fifteen to twenty minutes was noted. Some of these records were sent to Sir George Airy, who was then unable to account for them. Admiral Smythe referred to this phenomenon at Malta, where it had long been termed "Mirobia," and supposed to be due to distant storms. In 1878 Sir George Airy read a paper before the Royal Society upon the tides of Malta, in which he speaks of these undulations as simple harmonic curves, whose heads are sometimes notched as by the intermixture of small waves. That they had a marked time interval of twenty-one minutes and a range of twelve inches amplitude, much exceeding that of the lunar tides. He believed they were "seiches" similar to those discovered by Forel upon the Swiss lakes, and supposed them due to a reflexive action from the shores of Sicily and the African coast. Major Baird, of the Indian Tidal Survey, referred to this phenomenon in 1868 as being most pronounced at the ends of bays, but offered no explanation. In 1896 Professor Duff, of Purdue University, studied these undulations at St. John, N.B., and Indiantown, and later presented a paper before the Royal Society of Canada, in which he also classes them as "seiches," due to some form of oscillation between the two sides of the Bay of Fundy. He does not attempt any explanation for the abnormal movements often observed during fine settled weather. Mr. H. C. Russell, of New South Wales,

states that at Sydney what have been previously termed earthquake waves are in most cases due to atmospheric disturbances in some yet ill-defined manner, and have a marked twenty-six minute time interval from crest to crest.

Finally, these undulations are universal to a greater or less extent, as has been proved by a personal study of tidal records obtained from all parts of the world.

CHIEF POINTS DEDUCED.

1. That the undulations are due to the direct action of atmospheric waves upon the surface of the water at stations, and not to ground swells due to distant storms or "seiche" movements, as found upon lakes during atmospheric disturbances.

2. There is a marked relative correspondence in amplitude between the barometric and water undulations.

3. That they often appear during fine settled weather, when the barometer is high over the station but decidedly low to the south-west, frequently when over 1,000 miles distant.

4. That they increase in amplitude as the storm advances, the maximum usually occurring shortly before and at the time of the shift of wind, which also corresponds with the time of heaviest precipitation. This tends to prove that the axis of rotation of important storms is inclined towards the direction of its future course.

5. That after the storm has passed the station, these undulations rapidly diminish, although a heavy westerly gale may still be blowing, provided the temperature to the westward is fairly uniform; should a cold or warm wave be approaching marked undulations appear.

6. Should a south-west storm move with diminishing energy towards the station the undulations correspondingly decrease as it approaches.

7. That the tidal records are most disturbed during winter and least in summer, due to the velocity of the primary poleward current being almost double in winter what it is during the summer months.

8. The disturbed traces during the summer months chiefly occur shortly before or at the time of showers or thunderstorms, and usually precede warm and cool waves.

9. Whereas many of our storms are whirling eddies, developing from above downwards, it is hoped a further study of these undulations may throw much light upon their future growth and course, even before the ordinary barometer begins to fall.

10. Meteorologists throughout the scientific world now realize that for the further advancement of weather forecasting a better knowledge of the upper atmosphere must be obtained. Rapid strides are now being made in this direction by means of kites, balloons and cloud observations. May we not add the study of atmospheric and water waves at the bottom of this aerial ocean, which can be carried on during all conditions of weather by means of sensitive self-recording instruments?*

The various traces, termed "hydro-aerographs," obtained from such instruments, when more fully understood, will indicate to us certain wonderful forces at work far above, not visually discernible either through the dense lower clouds of an approaching storm or the clear blue sky of a fine winter's day. Also we trust that in the near future the installation of such instruments will become universal, and that Canada will lead in such an undertaking.

*Fully described in a paper read before the Toronto meeting of the British Association in August, 1897.

PROCEEDINGS
OF
THE CANADIAN INSTITUTE
NEW SERIES
VOLUME II.

TORONTO:
MURRAY PRINTING COMPANY, 11-13 JORDAN STREET.
1904

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PROCEEDINGS
OF
THE CANADIAN INSTITUTE.

PRESIDENTIAL ADDRESS. BY B. E. WALKER, ESQ., F.G.S.

(Read 12th November, 1898.)

The scientific student, or even the mere student of science, a quite different thing, by the way, should be one who seeks truth for its own sake, indifferent to the effect it may have on his preconceptions. If we turn to the last century, we find those who were interested in the physical history of the earth readily adopting the speculations of such men as Buffon and Werner, and so captivated by their plausible theories, based on little observation, that men like Guettard and Demarest, industrious observers who gathered facts before they ventured to theorize, were utterly disregarded, although their methods and conclusions were purely scientific in spirit and have helped to build the body of real truth which was so lamentably retarded by their brilliant contemporaries. Practically the spirit of original research and of open-mindedness in accepting the results of the researches of others, is of modern origin, and such liberty of observation and thought is even yet looked upon by some as a dangerous use of our faculties. There are still those who regard the modern spirit of enquiry as an attack upon whatever old foundations may seem to constitute orthodoxy in either religion or science. But this modern spirit of scientific study covers much beside the observation of truths connected merely with the physical and natural world around us. It covers practically all knowledge which may be systematized. It is that state of mind toward all phenomena which, if we were perfectly free from bias, would not permit us to vary any conclusion warranted by the facts, in favour of our preconceived ideas or beliefs. Of course very few, if any, can entirely escape the baneful effect of preconceptions, and it is to be feared that men of science are sometimes as dogmatic and prejudiced as others. Too many follow a quest in science which may not be truth, perhaps a quest of material gain, or of mere intellectual enlargement, by adding to the facts which sustain a theory already held. The scientific student should rise above all other considerations to the moral altitude of mere truth for its own sake. If it is a truth which he is unable to square with other truths, he should be willing that it should remain a disturbing anomaly until time shall have solved it. Let us, however, descend from these high levels into the so-called practical affairs of life.

There are those who question the importance of any new fact in the natural or physical world unless the material good to flow from it to man is apparent. What is the use of studying plants, or insects, or other inedible animals, or fossils? What is the use of Crookes's tube, they would have said a few years ago? And there are those of higher intelligence who although willing to admit the value of studies bearing on the origin of life, on evolution or some recognized philosophy, still question the wisdom of spending long years in the discovery of

facts which have no clear connection with other established items of knowledge. Many among the so-called practical men of the world realize the value of the entomologist who can do something to check the ravages of insects injurious to vegetation, the botanist who understands problems of forestry, or who with the added knowledge of the chemist knows the food or the medicinal value of plants, the geologist who happens to discover a coal or a gold mine, the biologist who actually saves human life by his knowledge of bacteria, or who by his knowledge of their habits shows how the fish supply of the world may be increased. But they do not always understand that the scientific discoverers who are thus able to do some direct good to man would not in all probability have attained such knowledge had they attacked the unknown fields of science in any other spirit than that which recognizes that all newly discovered items of fact are infinitely valuable, whether we can at the moment put them to any direct use or not.

No one is wise enough to recognize the full value of a newly-discovered fact. One new fact may seem to have nothing to recommend it, except its anomalous character. Another may seem of enormous importance. But some later discovery may change all this, disclosing the value of the apparently anomalous fact and diminishing the value of that which seemed the most important. Our duty is to treasure every new truth or fact discovered, no matter how unimportant it may appear. We can readily understand that what seems now of trifling value may be intimately connected with the working out of some problem in which man is deeply interested.

This may seem an unnecessarily elaborate manner in which to draw your attention to the claims of palæontology, the subject in which I hope to interest you to-night. In its early history it was peculiarly a study in which patience was necessary in recording facts which seemed to have little more than mere stratigraphical value to the discoverers. And even now that it may claim to be a body of systematized knowledge, its value is certainly underestimated in this centre of colleges and universities.

The simplest manner in which to judge of the value of any particular branch of science, such as palæontology, is doubtless to consider its interdependence with other branches of science. In the ultimate analysis, of course, all science is interdependent, but I refer to that interdependence which at once occurs to the student who desires to be a specialist. The entomologist soon finds that he must know something of botany, the botanist that he must know something of entomology. Both soon learn, also, that without some knowledge of geology, if only of soils and altitudes, they cannot proceed very far.

Let us, then, first consider the value of palæontology to the student who is trying to work out the physical history of the globe. In the record of fossils he finds almost his only sure guide. If he tries to work backward through the crust of the earth, beginning with the most recent conditions on the surface, he finds that there is but one satisfactory guide proving the regular succession of the different strata of rocks, and this is palæontology. If he concludes that the stratigraphical arrangement of the sedimentary rocks is for practical purposes the most satisfactory measure of time, he must also conclude that without the palæontological record there could be no system of stratigraphy, and that where the stratigraphic sequence is broken there is little beside the correlation of the fauna in the two unconformable strata from which to measure the time represented by the break in the sequence. It may be well to recount very briefly how our present knowledge of stratigraphy has been gained and the extent to which this knowledge is due to palæontology. The first attempt to systematize the rocks comprising the crust of the earth was made by the Freiburg professor of mineralogy, Werner.⁽¹⁾

(1) Many of the references to individual geologists have been taken from Sir Archibald Geikie's "Founders of Geology."

He advanced the theory that the globe was once completely enveloped in water—that is, that the water was high enough to cover the highest mountain. From and in this water the rocks forming the basis of everything were chemically precipitated. These, according to Werner, included granite, gneiss, mica-slate, clay-slate, serpentine, basalt, porphyry and syenite. He even asserted at first that the chemical deposition was made in the order in which the rocks are here arranged. These were his Primitive rocks, and they were followed by what he termed Transition rocks, some of which were of chemical deposition and some sedimentary. Then came the so-called Floetz rocks, partly chemical, but in the main sedimentary. It became necessary, however, to recognize the existence of volcanoes, and he taught an eager, listening world that volcanoes were the result of the burning up of seams of coal and other inflammable sediments; and that volcanic action was one of the most recent of physical forces at work in the earth. If ever there was an instance of the value of collecting facts, no matter how apparently dissociated from each other, until a system could be built which would defy attack, we have it in the Neptunist geology of Werner. He could not wait for facts, but theorized most brilliantly on the basis alone of what could be gathered in the mining district in which he lived. He contended that basalt was not volcanic, and satisfied most people, after a violent controversy, that it was not, and that obsidian and pumice were chemically deposited in water, while at the same time in France the patient, tireless investigator, Demarest, who refused to theorize, had laid before a world quite deaf to facts, the truth, as now recognized, regarding basalt and the real basis of what we know regarding volcanoes.

It is true that the great founder of accurate geology, Hutton, did not upset the theories of Werner and others by the aid of fossils, but he established forever the value of ascertained facts, of real evidence as opposed to theory. He laid down the great principle in geology, that we must judge of the action of the earth in the past by the action we see around us in the present. The doctrine of Uniformity in its extreme form is, of course, disputed by many.⁽¹⁾ but the main principle as here stated is generally accepted. Hutton thus settled, in many cases for all time, the manner in which the sedimentary rocks were created, setting aside the absurd notion of Werner's ocean depositing, chemically and by sediments, layers on the sloping sides of mountains covered to their tops by the sea. Hutton not only understood correctly the forces creating rocks but the destructive forces of erosion and the creation of watersheds and river systems.

But although both Werner and Hutton knew that the various rocks were created in succession and that in this succession there was an order which it was desirable to understand, other men laid the real foundations of palæontology in its relation to stratigraphy. As early as 1779 the Abbé Giraud-Soulavie, in France, set forth in a paper a stratigraphical description of a district in France in which the different strata were arranged by him in relation to their fossil contents, and in which he demonstrated that in the older rocks the fossils had no similar living species, while in some of the later rocks a percentage of the fossils were identical, or nearly related to living species. Little attention, however, was paid to these important truths, and his systematic arrangement of the rocks in question is not now recognized. The Abbé was followed by two great Frenchmen whom the world was obliged to regard. Cuvier and Brongniart were biologists who realized that they could not disregard the biological relations of fossils to living forms. Indeed, we owe it to Cuvier that palæontology is accorded its place in the study of biology, while Brongniart, in his zoology of the Trilobites, thus early demonstrated to what extent even an extinct tribe of crustaceans may be systematized and accorded their place in the order of natural history. But at the moment we

(1) Lord Kelvin "Popular Lectures and Addresses," vol. II., page 6. Prestwich's Geology, 1886, vol. I., page 2.

are concerned only regarding their contributions to stratigraphy. Working together, these two great men thoroughly studied the geology and palæontology of the Paris basin, and established the systematic arrangement of the Tertiary or Kainozoic formations so firmly that although many new minor divisions have been added, few alterations have been made, and the main features of the present classification are as they arranged them. They distinctly state that they based their classification and division of the rocks upon the fact that at the same horizon in a series of rocks, even when examined in widely separated places, they found that the groups of fossils were generally alike. Their conclusions, which in the complete form reached the public in 1808, were followed in 1813 by the results of the labours of another Frenchman, D'Omalius d'Halloy, who worked out with true stratigraphical principles the Secondary or Mesozoic rocks of France.

Turning now to the development of stratigraphy in England, as early as 1760 the Rev. John Michell had stated most intelligently the principles of the stratification of rocks, but he contributed nothing towards the nomenclature of a system. English stratigraphy practically began with the well-known William Smith. He was born in the same year with Cuvier, and outlived him seven years, but, instead of the splendidly endowed biologist, we have only a land surveyor, imperfectly educated. He drew up as early as 1799, although he did not publish it beyond distributing copies by hand among a few scientific friends, a card of the English strata, with a tabular list of formations from the Coal up to the Chalk, giving the thickness of the several members, lists of the fossils peculiar to each, and the lithological changes. In 1815 he published a geological map covering all England, of which all subsequent maps are practically but an elaboration, and he established the Jurassic system as permanently in England, besides much of our knowledge of the Secondary rocks, as Cuvier and Brongniart did the Tertiary in France. The geology of the Secondary or Mesozoic rocks in England as known to-day is filled with the names of formations given by Smith, and we owe to him the first sufficient arrangement of the Primary or Palæozoic and the Secondary or Mesozoic rocks from the Old Red Sandstone to the Chalk. So that he and the Frenchmen referred to cleared up on palæontological grounds the entire stratigraphy from the Old Red Sandstone to the present time.

Practically nothing was known in 1831 of the stratigraphy of the rocks below the Old Red Sandstone, and I have only now to refer to the splendid work of Murchison and Sedgwick in establishing as the result of investigation in England, Wales, Scotland, the Alps and elsewhere, the Cambrian, Silurian and Devonian systems; and of the subsequent investigations, still being pursued, to work out the pre-Cambrian rocks, the foundation efforts in which are now by common consent accredited to our own great geologist, Sir William Logan, whose portrait hangs upon our walls as the first President of this Institute. Sir Archibald Geikie, on whom I have drawn most liberally for personal facts regarding the early geologists, says:—“(1)” The determination of the value of fossils as chronological documents, has done more than any other discovery to change the character and accelerate the progress of geological inquiry.”

The geographical discoverer is unsatisfied as long as there is a shore line not marked upon the map of the world, and naturally the geologist is unsatisfied as long as there is a section in his geological column the nature of which he has not determined. We have shown how the geological column from the top or present time back to the base of the Cambrian has been determined satisfactorily by the aid of palæontology, and we have suggested the value of such a complete record to the student trying to work out the physical history of the globe. But the geological column extends below the Cambrian to the Archæan, representing a period of time regarding the measure of which the geologist, the biologist, and

(1) Sir Archibald Geikie, "The Founders of Geology," page 242.

the physicist are in most thorough disagreement. Are there no more fossils below the base of the Cambrian to illumine this dark period? In the Lower Cambrian of North America, according to Mr. Wolcott, one of the leading authorities on the Cambrian time, there are as many as 160 species, and these cover all classes of marine invertebrates. Clearly, then, in the Lower Cambrian we are not near the beginning of life on this planet, and surely we are not near the earliest preserved remnants of life.

The rocks in North America which are older than the Cambrian are divided by Dr. Dawson⁽¹⁾ in descending order, as follows:—

1. Keweenawan.
2. Animikie.

Here throughout a great part of North America, there occurs a profound unconformity.

3. Huronian.
4. Upper Laurentian or Grenville Series.
5. Lower Laurentian or Fundamental Gneiss.

It is evident that if fossils are found in any of these groups the Palæozoic division must be extended downward to include such groups and the Archæan division be that much diminished. A problem, then, of enormous importance awaits solution by the geologist. How much further down than the recognized Lower Cambrian will he be able to carry the record of fossil forms? In the present state of our knowledge we find vast areas of these older rocks which seem to be sedimentary, but which appear to contain no fossils, vast areas regarding which we are not sure whether they were sedimentary or not, and again vast areas which we believe we have proved never to have been sedimentary. About this confused period floods of argument have been written and many hypotheses advanced, but what we want are fossils. Fortunately we have a few, although they do not help us very materially. Mr. G. F. Matthew, who constitutes our main authority in Canada on the subject, considered palæontologically, has established as pre-Cambrian, but Palæozoic, beds in New Brunswick and Newfoundland which he calls Etcheminian,⁽²⁾ and which Sir William Dawson thinks to be equivalent to the Keweenawan.⁽³⁾ They contain "but a meagre fauna, mostly animals of a low type of structure, as Protozoans, Brachiopods, Echinoderms, and Molluscs," with worm-burrows and trails. Mr. Walcott, in a memoir on the Lower Cambrian,⁽⁴⁾ writes as follows:—

"The section laid bare in the Grand Cañon of the Colorado, beneath the great unconformity at the base of the known Cambrian, shows 12,000 feet of unaltered sandstones, shales, and limestones, that, I think, were deposited in pre-Cambrian time and should be referred to the Algonkian (Keweenawan). The entire section of pre-Cambrian strata is unbroken, and the sandstones, shales, and limestones are much like those of the Ordovician section of New York. In a bed of dark argillaceous shale, 3,500 feet from the summit of the section, I found a small Patelloid or Discinoid shell, a fragment of what appears to be the pleural lobe of a segment of a trilobite, and an obscure, small Hyolithes, in a layer of bituminous limestone. In layers of limestone, still lower in the section, an obscure Stromatopoid form occurs in abundance. These fossils indicate a fauna, but do not tell us what it is." In the same memoir, in a note at the foot of page 552, Mr. Walcott mentions the discovery of Salterella and fragments of a trilobite, 500 feet below a series of beds in Vermont which are 700 feet thick, of conformably bedded lime-

(1) G. M. Dawson. Presidential Address, Geological Section, B.A.A.S., 1897.

(2) G. F. Matthew. The Protolenus Fauna, Trans. N.Y. Acad. Science, vol. xlv., page 105, 1895.

(3) Sir W. Dawson. Note on Cryptozoon and other Ancient Fossils, Can. Record Science, vol. vii., page 203, Oct. 1896.

(4) C. D. Walcott. The Fauna of the Lower Cambrian, etc., U.S. Gov't Surv. Annual Report, page 550, 1888-9.

stone, and lie beneath the Olenellus Zone (the so-called base of the Cambrian). In the pre-Cambrian rocks of Wales and elsewhere fossils have been found, but not of a more satisfactory character than those already mentioned. I do not here discuss the so-called fossils of the Huronian and Laurentian, because until the vast beds of the Keweenaw and Animikie are cleared up it is hardly worth while to enter upon a mere controversy as to whether certain forms are fossils or not.

The subject is complicated by the many breaks or unconformities in Cambrian and pre-Cambrian times. In the extended areas of ancient rocks in North America there are sections where the Lower or some younger portion of the Cambrian rests directly upon Archæan or other pre-Cambrian rocks, and there are places where the section is conformable from the Cambrian series downward for many thousands of feet into the Keweenaw. Therefore, considering the many widely separated sections in North America, if at any point downward we were able to say we had reached the stage where in North America the Palæozoic rocks ended, it would seem at first sight as if we might conclude that the fossil remains found at this base, represented the beginning at least of organisms having hard parts. But presuming that the labours of Matthew, Walcott, and others eventually carry the Palæozoic record through the Keweenaw, down to the lowest of the beds of the Animikie, which "except when of volcanic origin," resemble "in their aspect the older Palæozoic sediments," we are then met, at least in the areas which Dr. Dawson has so happily called the "continental Protaxis of the North," with a gap in the record which he describes in the address from which I have already quoted, as "the vast lapse of time, constituting probably one of the most important breaks in geological history, by which the Cambrian and its allied rocks are separated from those of the Huronian and Laurentian systems." Regarding this break, Dr. Dawson says: "It would be difficult to deny that the time thus occupied may not have been equal in duration to that represented by the whole of the Palæozoic."

In the scattered and unsatisfactory fragments referred to above it cannot be said that we have found a fauna essentially different from the Cambrian, but somewhere—it may be in North America, in the Salt Range of India, in the Torridon sandstones of Scotland which are pre-Cambrian and said to be 10,000 feet in thickness, in Bohemia or Wales—we will doubtless be able to carry the history of the highly-developed trilobites and other organisms of the Cambrian at least further back towards their origin. This is the undiscovered shoreline in geology. In quest of it the Nansens of geology will travel as long as the limits of discovery are unsolved. We must not, however, forget that animals without hard parts leave no, or nearly no, record, and that the progenitors of many animals with hard parts had themselves no hard parts. In this connection Professor Marr,⁽¹⁾ after discussing the peculiarities of a well-known Cambrian trilobite, says: "If this be so, the entire outer covering of the trilobites, at a period not very remote from the end of pre-Cambrian times, may have been membranous, and the same thing may have occurred with the structures analogous to the hard parts of organisms of other groups. Indeed, with our present views as to development, we can scarcely suppose that organisms acquired hard parts at a very early period of their existence, and fauna after fauna may have occupied the globe, and disappeared, leaving no trace of its existence."

I have thus far been considering the value of fossils in demonstrating the position and relative age of the different strata of the earth's crust. It is not necessary for such purposes that the fauna of one stratum should bear any likeness to that of an immediately older or younger stratum. Indeed, to some extent,

(1) J. E. Marr. Presidential Address, Geological Section, B.A.A.S., 1896.

the less alike the better for mere purposes of distinguishing strata. It was, therefore, not unnatural that the early geologists, believing, as they did, that each particular animal or plant was a special effort of creation, should fail to recognize the value of biology in connection with the study of fossil remains. Indeed, when Cuvier and Brongniart, and, later, Deshayes and Lyell, undertook to correlate the organisms in the later rocks with living organisms—to point out where they were identical, where they were related but not identical, and where there seemed little relation—there were not wanting those who doubted the value of biology in the study of geology, and who persisted in estimating the value of fossils merely as guides in the stratigraphical arrangement of the rocks. Comparatively few fossils had been gathered, specific differences were often not recognized, the doctrine of evolution had not been advanced, and as I have already said, any particular fossil might be regarded as an organism whose history had no relation to anything but itself. The change which has come about in fifty or sixty years would be incredible were the record not clearly before us. I am not able to state even approximately the number of species now known, but a few detached facts will sufficiently illustrate the scope of modern palæontology. Prestwich estimated the species found in Great Britain in the Palæozoic rocks at 5,697, in the Mesozoic rocks at 7,546, and in the Kainozoic, including the Quaternary, at 4,013. That is, altogether, at 17,256 species, in the British Isles. This, as we know, is but a trifling part of the earth's area, although it is that which has been most thoroughly examined. Barrande estimated the Silurian species alone of Europe and America at 10,674, to which, of course, many have been added since the calculation was made. Every year great numbers of new forms are described and new territory is put under examination. No one would be so foolish as to attempt to guess the number of species which will eventually be recorded in science. If one will turn from the meagre text-books of the first half of this century to Zittel's⁽¹⁾ five large volumes, in which the first effort is made at a complete classification of all branches of palæontology, he will realize that the natural history of fossil animals is scarcely less perfect in its system of classification, or in its range of information, than the natural history of living animals. But it will be urged that after all we have only the hard parts of animals preserved. The soft parts are gone, and, worse still, the animals which had no hard parts have left almost no trace at all. This is quite true, and at first sight it seems an inestimable loss to the student of evolution. How will he ever fill the gaps in his record if only the bones have been preserved for him?

In the case of fossil animals having apparently no living analogues, had there been no theory of evolution there would doubtless have been no great desire to ascertain the nature of the soft parts, and thus to establish them in their proper places in the systems of natural history. And certainly in many cases, where the analogy is now clear, without this interest on the part of the biologist it would not have been suspected. But if in some class of fossil animals there are still a few living analogues, it is wonderful to what a degree the generic relations can be worked out and a system, satisfactory even to the biologist, be created, which shall include all the known extinct and living forms, even when the fossil species outnumber the living by a hundred to one. Allow me to illustrate this point by reference to the work done in connection with one of the most, if not the most, ancient order of shells, the brachiopoda. About 1884 Dr. Thomas Davidson, after thirty years' of labour on the subject, finished the first great work on brachiopods⁽²⁾. It fills five quarto volumes and is illustrated by 250 plates. What is perhaps more striking is the fact that the bibliography which completes the work, consists of 160 quarto pages, containing the titles of over 2,500 publications dealing with brachio-

(1) Karl von Zittel. *Handbuch der Palæontologie*, 5 vols., 1876-1893.

(2) T. Davidson. *British Fossil Brachiopoda*, vol. I.-VI., Publications of Palæontographical Society, 1850-1885.

pod. The brachiopod is a bivalve, but with valves of unequal size. In the overwhelming majority of cases in the fossil form the valves are found united, and, as the valves are filled either with sediment or with crystallized matter, the interior is rarely visible. This involved a greater difficulty than that of merely ascertaining the marks of the attachments of the organs on the inner sides of the shells. The brachiopods have supports for the soft parts, the so-called arms, in the shape of loops or spirals, or other processes, and while in modern brachiopods these are not calcareous, in fossil forms they were. These spiral and other processes were occasionally but rarely exposed and separated valves showing the muscular markings were also found, but naturally the first attempts at systematizing the brachiopods were largely based on mere external characters. During the progress of Dr. Davidson's labours, however, the Rev. Norman Glass, assisted him materially. By the exercise of great ingenuity and delicate workmanship he removed the shells and exposed the delicate brachial supports referred to, in the case of many species, so that a greatly improved system was the result. It is but right to say that others were working upon the brachiopods in the same direction, notably Mr. Whitfield, of the American Museum of Natural History, New York. The number of known fossil species has, however, kept on increasing at a surprising rate, and we have also added largely to the known living forms. Dr. Davidson's work was, therefore, soon followed by important contributions from D. P. Oehlert, in 1887,⁽¹⁾ and by Professor Zittel in his Hand-book, already referred to. It was still maintained that we possessed no treatise in which "facts in regard to structure, function, habits, and distribution of these animals, the distinguishing characters and systematic relations of their genera," are included in one work. This Professor Hall and his co-workers have sought to do in the "Introduction to the Study of the Brachiopoda" and in the eighth volume of the Palæontology of New York. Here we can readily follow their history from the very minute and rudimentary brachiopods in the Lower Cambrian through their enormous development in the Palæozoic both in numbers of individuals and in variety of form and size, continuing in lessened though still great numbers through the Mesozoic, and gradually lessening until the present age, of which Professor Hall records only 147 species, many of which are mere varietal forms. Whether we consider the shapes of the valves as they have been influenced by the soft parts which are now gone, the microscopic structure of the shells, the systems of defence by spines, imitative surface markings or otherwise, the infinitely varied and very beautiful processes for supporting the arms, the muscular scars, the complicated nature of the hinge, the foramen, the evidence as to fixity of habit or the reverse, or any other feature which may leave its morphological evidence on the fossil; or the softer parts which may be seen in living forms and by the aid of which both the structure and habits of the fossil organisms may at least to some extent be understood, we must admit that the history of the Brachiopoda, as gathered from the study of both fossil and living forms has produced a result infinitely more satisfactory to the biologist and the geologist than could have been possible by the study of the fossil forms alone by the old-fashioned geologist and of the living forms alone by the old-fashioned biologist. And he would be a foolish man who undertook to say whether the fossil or the living forms had most aided in the final result. Both are absolutely necessary.

In almost any other branch of fossil remains quite as valuable evidence of the growth of palæontology on its biological side might be adduced. In the Protozoans, George Jennings Hinde by his microscopic work is carrying the evidence of the existence of Radiolarian remains farther and farther back in the Palæozoic rocks, and Messrs. W. D. and G. F. Matthew have found Globigerinidae in phos-

(1) Paul Fischer. *Manuel de Conchyliologie*, Paris, 1887, with an appendix on the Brachiopods by D. P. Oehlert.

phatic nodules in the Cambrian rocks of New Brunswick.⁽¹⁾ In the Sponges Mr. Hinde has done splendid work,⁽²⁾ while Dr. Hermann Rauff has been some years labouring upon a systematic arrangement of all the known fossil forms.⁽³⁾ Professor H. A. Nicholson has made the first attempt at systematizing our knowledge of those difficult Hydrozoans, the Stromatoporoids,⁽⁴⁾ and Professor Lapworth and several other investigators are doing similar work upon the almost equally difficult Hydrozoans known as Graptolites. In the Actinozoans a vast quantity of work has been done on fossil corals since the epoch-making volumes of Milne-Edwards and Jules Haime,¹ but the great work of revision has not been undertaken as yet. In the Echinoderms, the camerate crinoids have been revised in a most elaborate manner by Messrs. Wachsmuth and Springer,⁽⁵⁾ and work of perhaps a higher character is now being done by Mr. F. A. Bather,⁽⁶⁾ of the British Museum. In the Crustaceans there have been monumental works such as Barrande's, but such important discoveries as those of Beecher and others in demonstrating the morphology of the underside of the trilobites, so long practically unknown, and the wealth of forms and knowledge of embryology and zonal conditions made known by the researches of Walcott and G. F. Matthew in the Cambrian will make a general revision necessary sooner or later. In the Molluscs, in addition to the Brachiopods, a great deal has been done by Professor H. A. Nicholson,⁽⁷⁾ E. O. Ulrich,⁽⁸⁾ G. B. Simpson,⁽⁹⁾ and others, in the Palæozoic Polyzoans or Bryozoans, both towards increasing our knowledge of forms and in systematizing our knowledge, although there is not enough agreement as yet for the comfort of the ordinary student. In the Molluscs good work is being done in every direction, notably in this country, in Mesozoic forms, by Mr. Whiteaves, of our Survey, but the time has perhaps not come for a general revision of any of the classes unless it may be the Cephalopoda. These have, throughout the history of palæontology, attracted great attention, but perhaps the work of Hyatt and of Zittel, based on palæo-biological lines, has been the most important from our own point of view. However, so many men of ability have devoted themselves to the Jurassic ammonites alone, that one is afraid to venture upon an opinion as to the probability of general agreement in a scheme of classification. In connection with vertebrate palæontology, it is not necessary to speak, as the names of Cuvier, Agassiz, Owen, and Cope, among those who have passed away, are well known to you all, and many distinguished workers remain who will continue to fill the gaps, making the vertebrate record more and more complete as the years roll by.

If I had time I should like to discuss the value of that kind of palæontological study, as it is now being carried on by certain investigators, in which regard is had to the stratigraphical relations of certain fossils on the one hand, and their biological relations on the other, in order to demonstrate their evolution. In the Quarterly Journal of the Geological Society of London,⁽¹⁰⁾ for August last, Mr. S. S. Buckman has divided the entire Jurassic system into minute zones, each zone

(1) G. F. Mathew. The Protolenus Fauna, Trans. N.Y. Acad. Science, vol. xiv., page 109, 1895.

(2) G. J. Hinde. British Fossil Sponges. Publication of Palæontographical Society, 1886-1893.

(3) H. Rauff. Palæospongiologie, Memoir in Palæontographica, edited by Prof. K. A. von Zittel, Stuttgart, 1893.

(4) H. A. Nicholson. British Stromatoporoids. Publications of Palæontographical Society, 1885-1892.

(5) Wachsmuth and Springer. North American Crinodea Camerata, Memoir, Mus. Comp. Zool., Harvard, 1897.

(6) F. A. Bather. As an example of Mr. Bather's Palæontological work, see Petalocrinus, Q.J.G.S., vol. liv., pages 401-441.

(7) H. A. Nicholson. The Genus Monticulipora, Blackwood, Edinburgh, 1881.

(8) E. O. Ulrich. Geological Surv. Illinois, vol. 8, 1890. Geological Surv. Minnesota, vol. 3, 1895.

(9) G. B. Simpson. Different Genera of Fenestellidæ, 13th Annual Report N.Y. State Geologists, 1894. Hand-book, N. A. Palæozoic Bryozoa, 48th Annual Report, N.Y.S. Mus. and 14th Annual Report N.Y.S. Geologist, 1895.

(10) On the grouping of some divisions of so-called "Jurassic" Time, S. S. Buckman, Q.J.G.S., vol. liv., pages 442-462, August 1898.

based upon a species of ammonite; and by the use of these zones in determining the precise age of one species relatively to another, he has been able to produce the genealogical tree of the Jurassic ammonites in a manner which should be satisfactory to the evolutionist. Doubtless this attempt to divide up the geological formations into zones named from apparently dominant species and to work out with this aid the phylogeny of families or orders may be carried too far. Clearly, however, by being able to divide the formations on biological grounds, so as to establish with reasonable precision the relative moment when a particular species arrived and flourished, and by being able to study young and mature individuals of the species so as to work out its embryology, great progress is being made in the history of the development of species through the medium of fossils.

I feel that I owe the members of the Institute an apology for the character of my address. My business duties preclude the possibility of engaging in original investigation even if I possessed ability of that kind. I have, therefore, merely sought by an address of a popular character to engage your attention regarding a branch of study which has been a source of deep interest to myself for many years.

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THE PREHISTORIC MONUMENTS OF BRITTANY. BY PROFESSOR A. B. MAC-
ALLUM.

(Read 3rd December, 1898.)

(Abstract.)

The menhirs, dolmens, and tumuli of Brittany, though much discussed, still offer problems for solution which are of importance in determining features of the Neolithic and Bronze periods. The age of these monuments also is undecided, for Fergusson⁽¹⁾ believes, that they are all post-Roman, while others claim for them an anterior origin. The difficulty in this matter is due to the fact that the remains were not, until the close of the last century, thought worthy of reference by writers who must have seen them. Cæsar, who was in the neighbourhood of Carnac when the sea fight between his galleys and those of the Veneti took place in the Gulf of Morbihan, makes, in his description of that battle, no reference to the thousand menhirs, which, if they were there then, he must have seen also at the time. On this ground Fergusson regards them as of later date, but one cannot depend very much on such a line of argument, for Madame de Sevigné visited Auray and the Carnac region in 1689, and although she wrote copiously about everything that apparently came under her observation then, she makes no reference to the existence of these monuments. Are we, therefore, to conclude that they were erected in the eighteenth century? On the other hand, the site of a Roman camp has been discovered in the area covered by the menhirs of Kermario, in the neighbourhood of Carnac, and some of the menhirs were used in the construction of the wall, while others inside the enclosure are blackened with soot, probably due to the legionaries using them as hearthstones. This clearly indicates an Ante-Roman date for the foundation of these monuments. In regard to the age of the dolmens of Brittany, the character of the skulls found in them is decisive—while the skull of the tribesman of Brittany in Cæsar's time was brachycephalic, that of the dolmen-builders was sub-dolicocephalic, or mesaticephalic. From this it is concluded that the dolmen builders were a race which preceded the Celts in Western France. How far back in time dolmens were first erected it is impossible to say, but it must be recognized that in North Germany, in Norway and Sweden, and in Ireland dolmens were erected in the Christian era.

In regard to the significance of the menhirs, nothing as yet has been definitely determined. Remains of human skeletons, accompanied in some cases by flint implements, have been found at the foot of some of them, and hence it is inferred that they are the equivalents of our burial headstones. This explanation must appear doubtful to anyone who has examined the "alignements" of Carnac. Here very few human remains have been found in connection with them, although there are thousands in the district. The view that the "alignements" were connected with sun-worship or with herpetolatry, postulates first of all an explanation of the function of the isolated menhirs in other parts of France and in Great Britain. Sun-worship undoubtedly obtained amongst ancient British and Gallic tribes, but the founders of the menhirs have yet to be shown to be of Celtic or Belgic affinities. There is very little evidence to show that serpent-worship obtained amongst these

(1) Rude Stone Monuments, 1872, chapter 8.

or amongst the earlier inhabitants of France. In the tumulus on the island called Gavr'innis, in the Gulf of Morbihan, the local guide points out to visitors a sinuous line which is believed to represent the serpent, but anyone who examines closely the rich sculpturing about it will see at once that the artist had no preconceived plan, and that the sinuous line, being made last, is the unforeseen, haphazard result.

It is difficult to believe that the "alignements" were not connected with some religious observances or creed. The extraordinary size of some of the menhirs forming them, and particularly of the fallen and broken one near the Dol des Marchands, is such as to force one to question whether any influence, save religious, could have compelled the founders to undertake the gigantic toil of their erection. Undoubtedly they must have been regarded as sacred objects, and this leads one to understand why they were used in some cases for human burial. Their use, therefore, as burial monuments may have been secondary. We have an instance of such secondary use in the case of cathedrals and churches of to-day. The existence of stone circles or cromlechs, like the one which terminates the alignements at Menec, would further seem to strengthen the view that all these monuments were in some way connected with religious observances.

The dolmens present less difficulty as to their significance. They are more or less caverns formed in many cases of gigantic stones which are usually only partially sunken in the earth, and covered by very much larger flat stones, often weighing many tons. In these chambers have been found human bones, flint and sometimes bronze implements, with some specimens of rude pottery. Wedge-shaped specimens (*celts*) of jade, or green stone, have also been found in some dolmens. This bears on the "axe" cult which undoubtedly obtained amongst the dolmen-builders. In the dolmen near Locmariaquer, called the Dol des Marchands, a large figure of an axe is engraved on the under surface of the covering stone. On the large flagstone on the floor of another dolmen of that neighbourhood, the *Mand-Lud*, there is a very large figure of an axe in relief. This is pointed out by the local guide as the figure of a sword. On one of the flat stones taken from the tumulus to the south of Locmariaquer, called *Mand-er-H'rouc*, there are many axes sculptured. In order to understand the significance of these figures, one must compare them with what has been observed in several of the Marne caves. In these are three instances of a female figure rudely sculptured, associated with the outlines of hafted axes. In the dolmen of Collorgues, in the Department of Gard, the slab forming the central part of the roof has a female figure rudely outlined, and under it is cut the figure of an axe. All these sculptures have been found associated with burial. The axe, therefore, was the symbol of some cult, believed to be that of a deity who is now termed the "Axe Goddess." This cult was accepted by the Celtic and other contemporaries and successors of the dolmen-builders in Gaul, and was continued even during the Roman occupation, for amongst the Romanized Gauls the practice obtained of putting a figure of an axe on a headstone, or in place of the figure the words, "*sub ascia*," or "*sub ascia dedicavit*." What the cult of the Axe Goddess signified it is impossible to do more than conjecture. Its association with death and burial possibly points to the belief in a goddess of death. The cult has for students of the origin of religions this important interest: it is the only one we know as belonging to the Neolithic age, and, further, it was handed down from Palæolithic times, or at least from the transition period between the Palæolithic and Neolithic ages, when the caves were not inhabited, but used as burial places. Borlase⁽¹⁾ attempts to show that the cult obtained over the whole of Western Europe, and he claims that indications of it are shown in the pottery of Hissarlik found there by Schliemann. That it had a wide range may be granted, for in Palæolithic times there was probably one race

(1) The Dolmens of Ireland, vol. II., page 578.

occupying the whole of Europe, and this fact would account for a wide diffusion of ethnic and religious ideas, but it may be doubted if some of the figures, e.g., those of the pottery at Hissarlik, supposed to be those of the Axe Goddess, are more than accidental resemblances to the symbols of her cult.

The tumuli were undoubtedly used for the sepulture of important persons, such as kings, chiefs or leaders, and their relatives. It is not improbable that they may have been used in the case of certain religious rites, for in the tumulus called Mané-er-H'roec, at Locmariaquer, and in Mont St. Michel, at Carnac, a large number of celtæ (stone axes) were found, and these have been regarded as votive offerings either to the Axe Goddess, the manes of the dead, or to the Divinities of death. In many of the tumuli the bones found were more or less incinerated, proving that cremation was practised. On the exposed surface of the greater number of the slabs forming the walls of the tumulus of Gavrinis the line-tracing or sculpture is very rich, and gives a marked distinction to this tumulus. It would seem to have been the tomb of a king.

It is in the dolmens, however, that one finds the largest number of inscriptions. These have not been deciphered. They would appear to consist of two kinds—one ornamental, good examples of which are to be observed in the upright supporting stone of the Dol des Marchands, the second totemic of which examples are to be found in the dolmen at Kerioned, in the Alée Couverte des Pierres Plates, near Locmariaquer, and in the Alée Couverte of Luffang. A curious fact is that in the two last named there are the outlines of the same figure, which seems to the writer to be that of an opened lentil pod. On one of the slabs in the Mané Lud dolmen there is an inscription which is difficult to classify. It is clearly not ornamental, and it is not totemic, for an almost similar one has been described as found in the New Grange tumulus, near Drogheda, Ireland. Something similar is to be observed on one of the vertical slabs at the end of the cavern in the Gavrinis tumulus, but here the outlines are less readily traced, owing to the surrounding lines of sculpture following the curves of the inscription. It may be hieroglyphic in function.

Of what race were the dolmen builders? The definite answer to this question would determine also who were the founders of the menhirs and of the tumuli, for it is generally conceded that the three classes of monuments may have, in Brittany at least, been built by the same tribe or race. Though first looked upon as of Celtic origin, it is now recognized that they are the remains of a race which inhabited the western and north-western part of Europe before the advent of the Celts. This race, known as Iberian, also occupied Ireland, Wales, and the western portions of England and Scotland, and thus the distribution of dolmens and other megalithic remains would be accounted for. There are, however, difficulties in accepting this view. The dolmen-builders were mesocephalic, the Iberians dolichocephalic. The Iberians who inhabited the Dordogne district and the portion of the Landes district, including Dax and its neighbourhood, from Palæolithic times, did not build dolmens, and in all the country lying between the Garonne and the Pyrenees, inhabited in Cæsar's day by the Aquitani, a tribe of the Iberians, there are very few megalithic remains.

The explanation of these difficulties can only be conjectural. According to Collignon⁽¹⁾ the Iberians were not a race, but an assemblage or collection of tribes, derived from three races which inhabited from the earliest times the Spanish peninsula. These were the Neanderthaloids of Gibraltar, a people like the Cro-Magnon race, and the type called by de Quatrefages the race of Mugem, whose remains are to be found in kitchen middings, on the banks of the Tagus. Accepting this view, it would be possible to regard the Aquitani as a less mixed race descended

(1) Les Basques. *Mémoires de la Société d'Anthropologie*, 3d Serie, Tome 1, Fascicule 4, page 55.

from the Cro-Magnon type of Palæolithic times, and, therefore, not possessed of the same customs as the more mixed Iberian race or tribes. Sergi,⁽¹⁾ on the other hand, claims for the Iberian race a single African origin, and that as a uniform race it spread over Western France and the British Isles.

It would appear that in order to ascertain definitely who the dolmen builders were it is necessary first of all to determine clearly the origin and history of the Iberians, and this can only be done when the anthropology of the Spanish peninsula is as fully worked out as that of France.

(1) Ursprung und Verbreitung des Mittelländischen Stammes. Autorisierte Uebersetzung von A. Byhano Leipzig. Verlag von Wilhelm Friederich.

CORUNDUM IN ONTARIO. BY ARCHIBALD BLUE, ESQ.

(Read 10th December, 1898.)

Just one hundred years ago, in a paper read before the Royal Society of London and published in its Transactions, Rt. Hon. Charles Greville established and named the mineral species Corundum, the crystalline oxide of aluminium; and we have it on the authority of Professor Judd that in an appendix to Greville's paper the Count de Bournon correctly defined the crystallographic characters of the species. The names of its gem-varieties, sapphire and ruby, had been in use from a much earlier time;⁽¹⁾ and the name corivindum, or corrivendum, had been given to it by Woodward, in a vaguer way, as early as 1714.

In the western part of Asia Minor, and in some islands of the Grecian Archipelago, the crystalline limestone which is interbedded with the schists and gneisses carries a blue corundum mixed with magnetite, which is the emery of commerce. The corundum occurs in smaller quantities as a constituent of granite and gneiss in Silesia, Auvergne and elsewhere in Europe; in a compact felspar rock in Piedmont; in dolomite with tourmaline at St. Gothard; in crystalline limestone, along with numerous other minerals, in Orange and Westchester counties, New York, and Sussex county, New Jersey, and at various localities in Connecticut, Massachusetts and Pennsylvania. It is said by Dana to be common at many points along a belt extending from Virginia across western North Carolina and Georgia to Dudleyville, Alabama.

In Burma, which became a British Province in 1886, ruby mines have been worked for a very long period. There the country-rock is chiefly gneiss, with bands of crystalline limestone of varying thickness and many miles in length. Most of the mining has been carried on in the hill-wash and alluvium carried down from the decomposed summits of hills and mountain ranges; and it has been observed that where the sands and gravels are mixed with a dark brownish earthy clay, which is a product of the decomposed crystalline limestone, they are richer in such gems as ruby and spinel. The explorations of Barrington Brown appear, indeed, to have satisfactorily established that in Burma the only rock in which rubies are found in place is crystalline limestone. "It is of the usual composition and character of ordinary crystalline limestones," says Mr. Brown, "being made up of finely crystalline or granular limestone in layers, together with irregularly shaped bands of very coarsely crystalline limestone of white and bluish colors, which are interfoliated with the gneissic rocks." Where a quarry has been worked, near Mogok, the matrix of the ruby is a coarsely crystalline, semi-opaque limestone of about twenty feet in width. The rubies are found over a space of six feet in width, extending almost vertically from the bottom of the quarry to the surface of the ground, and along the centre-line, where the rubies are most numerous, are small developments of a grayish diaspore enclosing small crystals of iron pyrites. As to the limestone itself, whether occurring as disseminated crystals through the gneiss or as great interfoliated masses, it is the opinion of Professor Judd that it has been neither organic nor due to direct chemical precipitation in its origin, but

(1) In the Burma Corundum every shade of colour, from white to the highly prized deep crimson or pigeon's blood, is found, and they are named according to colours instead of composition or system of crystallization,—the red variety as oriental ruby, the blue as oriental sapphire, the yellow as oriental topaz, the purple as oriental amethyst, and the green as oriental emerald.

has resulted from a metamorphism of the lime-bearing feldspars; while during the process of change from basic feldspar to scapolite, and from scapolite to hydrated aluminium silicates, and from these to aluminium oxide, "the slowly liberated oxide may assume the crystalline form, and thus give rise to corundum." Among other minerals found in the corundiferous limestone are pyrrhotite, hematite, apatite, graphite and spinel.

In Ceylon, in the peninsula of India, and in China, there are numerous occurrences of corundum in crystalline schists; and in almost every case the mineral is of the gem variety. As far as known to the writer, there are no deposits in Asia now exploited for use in the arts, saving the emery of Asia Minor.

In the United States corundum is confined almost wholly to the region of the Appalachian Mountains, along a belt that extends from New Jersey to Alabama. In the form of emery it is found at Chester, Massachusetts, in a chlorite belt about twenty feet wide, that lies between formations of hornblende-schist and talc, and traverses the mountains for about four miles. There is also a productive emery mine in Westchester county, New York, which ships from 500 to 700 tons of abrasive emery per annum.

Along the Appalachian mountain chain corundum is found in feldspar veins and associated with chlorite in peridotite and serpentine rocks, in amphibolite, dunite and gneiss, as well as in gravel-beds. The principal deposits are found in association with magnesian rocks, chiefly peridotites, which occur as small lenticular masses in gneiss. As a rule, however, the corundum is neither in the peridotite nor in the gneiss, but in a narrow zone of chloritic minerals between the two. The largest known areas are in the south-western counties of North Carolina, where corundum was first discovered in 1870. This state has furnished nearly all the corundum of commerce for the United States, but the statistics of the mines and works have never been published. There has been much waste of effort in mining for the gem varieties, encouraged by occasional discoveries, but chiefly by the attractive colors in which the corundum is found. The whole process of mining and milling has had to be learned by experience; and the task has been made difficult not only by the character of the formations, which is not favorable to sinking or drifting, but also by the closeness with which the corundum crystals adhere to the matrix.⁽¹⁾ For abrasive use it is very important that the corundum should be free from particles of rock or mineral softer than itself; and for use as an ore of aluminium it should be free from all impurities, to make extraction practicable by present methods.

The first discovery of corundum in Ontario was made by the late Sterry Hunt fifty-one years ago, in the second year of his connection with the Geological Survey of Canada. Dr. Hunt explored part of the county of Lanark in 1847. He was joined in some of his excursions by Dr. Wilson, of Perth, who at that time enjoyed some local reputation as a geologist (the mineral wilsonite is named after him), and who is still remembered as a man who paid considerable attention to the natural history of his district. The first place visited by them was the fourth lot on the eighth range of the Township of Burgess, upon which Dr. Wilson a short time before had discovered a body of apatite. Near by, on the second lot on the ninth range, was a deposit of copper pyrites in crystalline limestone, and this was also visited. The only exploration work consisted of two or three blasts, and among the masses of rock thrown out were some consisting of silvery mica, with quartz, feldspar or albite, and calcspar, holding a delicate emerald-green and almost transparent pyroxene of rare beauty, as well as crystals of a dark honey-yellow

(1) Mr. Alexander Rickard of New York, who is owner of a corundum property at Energy, in York County, South Carolina, says, in a letter to me of recent date: "All our corundums are very difficult to clean. While the gangue is soft, it is tough, and adheres to the grains of corundum when it is broken up. This reduces the cutting value, and also creates trouble by flaking when making into wheels."

sphene. The mica was often aggregated in masses of small crystals, having a columnar arrangement,⁽¹⁾ imbedded in which, and disseminated throughout the rock, were a great number of crystalline grains of a transparent mineral, varying in color from a light rose-red to a deep sapphire blue. Dr. Hunt, in his report to Sir William Logan, said:—

"Their hardness, which is so great as to enable them to scratch readily the face of a crystal of topaz, showed them to be nothing else than the very rare mineral corundum, which from its colors is referable to the varieties known as oriental ruby and sapphire. The grains obtained were small, none indeed larger than a pepper-corn; but at the time I was on the spot they were not noticed, and the specimens were collected for the pyroxene, in only two or three of which I have since detected the corundum. It is probable that further examinations may develop larger and more available specimens of these rare and costly gems. It is in this crystalline limestone that they generally occur, and the corundum found in the State of New Jersey is in the same rock and with similar mica."

Yet it does not appear that this discovery in Burgess received further attention from Hunt or other members of the Geological Survey, and the mineral was practically re-discovered there a year ago by Professor Miller, of the Kingston School of Mining. It will be noticed from Hunt's account that the specimens were collected only for their pyroxene, and that the crystals of corundum were not noticed or identified until a later time.

The largest known deposit of corundum in the Province was discovered twenty-two years ago on the farm of Henry Robillard, in the township of Raglan, Renfrew county; but in this case twenty years elapsed before the mineral was correctly identified. According to Robillard's story, he was returning with his little daughter from a cranberry marsh on the wide flats of York river, and, in climbing a hill which rises about 500 feet above the river, he sat down upon a large boulder to rest. In telling me the story Robillard said:—

"Annie was kneeling behind me, and picked up a queer-shaped stone, and, showing it to me, said it looked like the stopper of a cruet-bottle. It was just like that; and I wondered what fool of a man had gone to work and whittled it out. Then I looked at the stone where I was sitting; and, bless you, sir, it was paved with cruet-stoppers. And here is the very boulder now," he added, as we reached the spot, about half-way down the hill.

Specimens gathered by Mr. Robillard were shown to several persons in Combermere, and one who professed to be a miner of phosphate of lime in Lanark county pronounced them to be crystals of that mineral. In 1884 one John Fitzgerald joined with Robillard in an application to the Crown for the mineral rights on the property, including several lots on the 18th and 19th concessions of Raglan; and for a number of years they sought in vain for a customer to buy an apatite-mine. The sturdy pioneers would brook no contradiction of their claim that the mineral was veritable apatite; and when a doubt was raised by two young mineralogists who visited the region about ten years ago in the interest of a capitalist, and a suggestion was meekly made that it might be emery, one of the pioneers cut negotiations short by threatening to "punch their heads." Last year, how-

(1) It is not improbable that these were decomposed or altered crystals of corundum. On the metamorphoses of the mineral Professor Judd says: "At the earth's surface, as is well-known, corundum or the crystallized oxide of aluminium is one of the most unalterable substances. Fragments found in river gravels and sands, though perfectly water-worn, show no trace of chemical alteration in their surfaces. On the other hand, there can be no doubt that conditions must exist in the earth's crust under which chemical change of this mineral does take place; this is abundantly proved by the frequency with which undoubted pseudomorphs of corundum occur. Among the minerals found replacing corundum as pseudomorphs are muscovite (damourite), various forms of spinel, andalusite, fibrolite, cyanite, margarite, chloritoid, zoisite, ripidolite and other chlorites, various vermiculites, kaolin, and other substances."

ever, these pioneers were overjoyed to learn on the authority of an expert that the mineral was not apatite, but corundum.

Eleven years ago Professor Coleman, now of the School of Practical Science at Toronto, picked up some boulders of nepheline-syenite in the vicinity of Cobourg, on the shore of Lake Ontario, which held crystals of corundum. A fortnight ago I showed Dr. Coleman several specimens of nepheline, rich in corundum, which I had taken from a large deposit recently discovered in the township of Dungannon, and he at once pronounced them to be identical with his own. "I feel sure now," he said, "that I know where my float-boulders came from."

Twelve years ago, in 1886, Nesbitt T. Armstrong, a farmer and mill-owner in Carlow, discovered corundum on lot 14, in the 14th concession of that township, but he did not know its name, and did not suspect that it possessed any value. A sample was shown to a student of Toronto University, who thought it might be emery; and inquiry stopped there. But in 1893 Mr. W. F. Ferrier, lithologist of the Geological Survey, acquired by purchase a number of specimens collected by Mr. John Stewart, formerly of Ottawa, among which was a package labelled "Pyroxene crystals, south part of Carlow." On examining these specimens some time afterwards, presumably in 1896, Mr. Ferrier recognized them as corundum, and immediately took steps to ascertain the precise locality from which they came. In October, 1896, he was sent upon this mission by Dr. Dawson, the head of the Geological Survey, and, guided by Mr. Armstrong, he found the corundum in place upon the lot on which Armstrong's discovery had been made ten years before. Then for the first time the fact was established, on the best authority, that this mineral had been found to exist in Canada in commercial quantity, and that it was valuable as an abrasive material on account of its great hardness. But as it was too late in the season for field-work, Mr. Ferrier did not extend his explorations beyond that one locality.

The first geological reconnaissance of the district in which corundum has been found was made by the late Alexander Murray, of the Geological Survey, in 1853; but his notes of it are very meagre. Mr. Murray made two traverses of the country lying between Georgian Bay and Ottawa river—the first from west to east, by way of the Muskoka and Petewawa rivers, and the second by way of the Bonnechere and Madawaska, to the headwaters of the Trent. The source of the Bonnechere is within a mile of Kaministiquia lake, on the Madawaska, near to where Barry's Bay station, on the Ottawa and Parry Sound Railway, now stands. Mr. Murray descended the Madawaska to the mouth of its principal tributary, the York branch, or York river; known, also, at that time, by its significant Indian name of Shawashkong, or Mishawashkong, the river of the marshes. The course of this stream, which Mr. Murray ascended, lies for more than forty miles within the corundum belt: and along its banks are numerous exposures of syenite, with occurrences of nepheline-syenite. But no reference is made in the report to the rock formations; and the record of levels for the first ten miles is of very doubtful accuracy.⁽¹⁾

Forty years elapsed before another attempt was made to work out the geology of this interesting area, and the task was then entrusted to the very capable hands of Dr. Frank D. Adams. The area under examination is comprised in sheet 118 of the Ontario series of geological maps, and the four corners of it lie in the townships of Digby, Finlayson, Hagarty and Grimsthorpe respectively, embracing an area of about 3,500 square miles. In his first report, made for the season of 1893, Dr. Adams sketched briefly the geological features of the district, the northern portion of which he found to be occupied exclusively with the ancient crystalline rocks of the Laurentian system, and the southern and eastern portions with the

(1) The rock formations along the York River, however, are carefully noted on the maps which accompanied the report, as are also the waterfalls and rapids of the river from its mouth to its source.

limestones and gneisses of the Grenville series. "The discovery of so large an area of the Grenville series in this district," Dr. Adams says in his report, "is most encouraging, as indicating the probable occurrence in it of large and valuable mineral deposits." An extensive and remarkable mass of nepheline-syenite was discovered in the townships of Faraday and Dungannon, which was traced for a distance of over seven miles in an east and west direction. Dr. Adams says: —

"This is a rare rock, found in but few places in the world, and never before discovered in our Laurentian system. The nepheline is very abundant, forming in many places an almost pure nepheline rock. The mass is flanked on the south, along a considerable part of its course, by crystalline limestone, and it is also intimately associated with a fine-grained reddish rock, resembling aplite. It is of a prevailing gray color, and often has a distinct foliation, coinciding with that of the associated rocks."

The beautiful blue mineral sodalite was also found in a number of places, associated with the nepheline-syenite, in the form of veins and irregular masses; but no occurrence of corundum was observed.

During the past three seasons Mr. Barlow has been associated with Dr. Adams on the work of this field, and a very interesting and valuable report may be confidently looked for upon some of the most intricate questions of Archæan geology. Dr. R. W. Ells has also been engaged at intervals in surveying portions of the Ottawa valley east of the area on which Messrs. Adams and Barlow have been working, into which the corundum belt is known to extend as far at least as the Ottawa and Opeongo road. The two map-sheets, however, as well as the accompanying reports, will deal with the general geology of the districts, and notwithstanding the importance of the corundum discovery it is not likely that prominence will be given to that subject, if the usual practice of the survey is followed.

During the last two seasons Professor W. G. Miller, of the Kingston School of Mining, has been employed by the Ontario Government to make a special report on the field. Beginning last year with the study of the occurrence of the mineral at the place of first discovery in Carlow, he has been able to trace the corundum-bearing rocks eastward across that township, through Raglan and Lyndoch, to the shores of Clear lake, near the eastern line of Sebastopol, a length of about 30 miles. The breadth of the band varies from half a mile to three or four miles, and its total area embraces about 60,000 acres. The prevailing country-rock of the district is gneiss, composed chiefly of hornblende, biotite and feldspar, and it is probably an altered gabbro. Numerous dykes or masses, consisting largely of feldspar, cut through the older rocks, which sometimes have the character of coarse syenite, passing in places into nepheline-syenite. In both of these rocks corundum was found, as well as magnetite, pyrite, garnets, zircon and sodalite. In continuing his work this year Professor Miller has succeeded in tracing the syenite band continuously for about 75 miles, from the township of Glamorgan, in Haliburton, to the township of South Algona, in Renfrew, besides tracing it to a considerably greater width over the region explored last year. Corundum was found at a number of places in the western part of the belt, and a large and apparently rich deposit in a ridge of nepheline-syenite near the middle of it in the township of Dungannon. But as the rocks, over nearly the whole of their extent, are covered with sand, it is probable that many valuable deposits remain to be discovered. The total area of this band is about 300 square miles; and, as it lies in a Free Grant district, the mineral rights are reserved by the Crown in almost all the lots that have been taken up for settlement. In a few cases, where lands were sold more than thirty years ago, the mineral rights went with the surface rights; and since that time some lands have no doubt been sold or leased as mining lands. But it is safe to say that the Crown holds for disposal the minerals in at least 90 per cent. of the whole tract.

Two years ago corundum was found in a property that was being worked as a mica mine in the township of Methuen, in Peterborough county, about 45 miles southwest from the original discovery in Carlow. This locality has also been explored by Professor Miller this year, and the corundiferous band of syenite has been traced in a northeast and southwest direction about six miles, with a width of two miles. The range of hills over which it extends is known locally as the Blue mountains, and at its southwest end it reaches the shore of Stony lake.

I spent the last week of September with Professor Miller in going over the more northerly band, from the easterly end of it, on Clear lake, in Sebastopol, to the village of Bancroft, on the Hastings road, on the line between Dungannon and Faraday. Only a few of the principal properties were visited, including the Block location in Brudenell, the Robillard location in Raglan, the Armstrong location in Carlow, and a recent discovery in Dungannon, not far from the York river. All these are large deposits, easy of access, and favorably situated for mining operations.

Where the exposure occurs on the Block farm the crystals are in syenite, and are thickly studded in the face of the rock. Outcroppings of nepheline-syenite occur near by; and, owing to its resemblance to limestone, an attempt was made by the owner to burn it for lime. The crystals of corundum have a bronze lustre, and vary in size from half an inch to an inch in diameter. Numerous boulders are strewn over the face of the ground which carry a high percentage of the mineral; and in some cases the crystals are nearly pure white in color.

On the Robillard hill corundum may be traced for a mile or more along its southern face, wherever the syenite is exposed. The corundum crystals are frequently observed to run in strings several inches wide along the surface of the rock, and are of all sizes from half an inch to two or three inches in diameter, usually barrel-shaped, and ranging from an inch to four or five inches in length. On the western shoulder of the hill there is an outcrop of nepheline-syenite; and in this rock the crystals are finely shaped, but of small size—about a third of an inch in diameter and an inch or an inch and a half in length. An expert who has examined this hill estimates the corundum in sight at several millions of tons. There is certainly a large quantity, and in some places it amounts to from 30 to 40 per cent. of the rock mass. Along the foot of the hill are numerous large boulders of syenite, speckled over with crystals like plums in a pudding.

The Robillard hill is cut off by a stream upon its west side from a range of high hills that extends westward five miles into Carlow. Professor Miller has carefully examined this range, and has discovered corundum in it at a number of points. The largest showing, however, is on the Armstrong lot, where another stream cuts through, on its way to join York river. The rock has scaled off so as to show a perpendicular face about 300 feet in length and 30 feet in height, exposing a mass of syenite which has been thrust up through the gneiss, and which, in its turn, has been cut by a dyke of pegmatite. The gneiss has been thrown up to form an anticlinal arch over the syenite, but is cut through along the north side, where the syenite dyke is well exposed with a thickness of ten or twelve feet. According to Mr. Ferrier, it has been traced along the strike about 700 feet. Crystals of corundum are numerous on the exposed face of the syenite, and are also found in the pegmatite nearest the syenite, which is composed chiefly of felspar. But where quartz comes in with the felspar, the corundum disappears. A lot of several tons, taken without selection from this location last year and treated at the Kingston School of Mining, yielded from 12.75 to 15.5 per cent. of corundum.

The last location I examined is in the township of Dungannon. It is in a ridge of nepheline syenite, having a width of 90 to 100 feet, and rising upon one side to a height of about 60 feet. My time only permitted me to follow it for a length of about 150 yards, but Professor Miller informed me that he had traced it

for half a mile. The whole surface, as far as I examined it, was thickly strewn with small crystals of corundum, ranging in color from pearl to blue; but here and there parts of it were altered into white mica. A sample of it, assayed for me under the direction of Dr. Coleman, carried nearly 10 per cent. of corundum, and was remarkably free from iron. An ore of this character ought to be well suited for the production of aluminium, especially as the nepheline itself, the gangue rock, contains about 30 per cent. of alumina.

Here it may be remarked that, owing to the presence of iron and other impurities, makers of aluminium assert that native corundum is unsuited for the production of that metal. But it is safer to keep an open mind on problems of this nature. When one reflects that by the adoption of new and improved processes the cost of producing aluminium has been reduced, within forty years, from its weight in gold to 30 cents per pound or less, one ought not to assume that it is impossible to find a process for producing pure corundum at low cost, if not a process to make aluminium out of an impure ore. Professor DeKalb, of the Kingston School of Mining, was able last winter, with a small experimental plant, to extract corundum (99.61 per cent. pure) from rock that carried five per cent. of magnetic iron ore. What, then, might be expected from a large and well-equipped plant, capable of treating 50 or 100 tons per day, supplied with every device that the wit of man can invent, and especially with a good quality of rock to work upon? In one particular the Ontario mineral appears to differ from the mineral of the Appalachian belt; the gangue is brittle, and is easily broken up and separated from the corundum.

It will certainly add greatly to the value of the corundum deposits of Ontario if they can be used in producing aluminium as well as the material for abrasives, if the history of that metal during the last ten years is a fair index of its future. In the ten years ending with 1897 its production in the United States has risen from 19,000 pounds, valued at \$3.42 per pound, to 4,000,000 pounds, valued at 37½ cents per pound; and so much progress in so short a time seems to be ample justification for the statement of Professor Richards, made three years ago in the preface to his admirable book on aluminium: "The abundance of aluminium in nature, the purity of its ores, its wonderful lightness and adaptability to numerous purposes, indicate that the goal of the aluminium industry will be reached only when this metal ranks next to iron in its usefulness to mankind."

None of the discoveries hitherto made in Ontario seem to encourage the hope that gem varieties of the corundum are to be found, although in some localities an occasional crystal is to be seen with qualities not unlike sapphire, being semi-translucent and of bluish color. Perhaps, if search were made in the crystalline limestones, it might be rewarded with better success; not that corundum of any quality has yet been found in the limestones, but because their relations to the gneiss are not dissimilar to those which obtain in Burma. When the source of the limestones has been worked out, it may be shown that, like those of Burma, they have been derived by metamorphosis from the felspar of the gneiss, or perhaps from the felspar of the syenite; and if so, the analogy would suggest that these rocks are worth prospecting for corundum in some of its more valuable forms. In a note received from Professor Miller on this subject, he says:—

"It is quite possible that corundum may yet be found in considerable quantity in crystalline limestone in Ontario, as in India and Burma. In India the mineral occurs under various conditions in metamorphic (limestones, etc.), and igneous rocks. Of course there need be no connection between the occurrence of the mineral in these two classes of rocks. If corundum occurs in our crystalline limestones, it is of a different origin from that occurring in the igneous rocks (the syenites)."

The crystals discovered by Sterry Hunt in Burgess, it will be remembered, were found in association with pyroxene in crystalline limestone.

In view of the extent and apparent richness of the corundum fields in the Province, the Government has taken steps aimed at developing the deposits and establishing a home industry. Regulations have been drawn up under which the mineral rights in lands lying within the two corundiferous belts have been withdrawn from sale, and hereafter the mineral and mining rights in such lands can be acquired only under the leasehold system—the rental for the first year being 60 cents and for subsequent years 15 cents per acre. Instead of allowing speculators to take up and hold lands with a view to sell out their interests to miners and capitalists at a large profit, it is proposed that the advantage of acquiring lands upon the lowest terms shall go to the miner and manufacturer direct; and in the case of parties who will undertake to conduct mining and treating operations on the largest and completest scale, and who can furnish satisfactory assurance that they possess the requisite capital for the proposed operations (including separation of the ore from its gangue, milling for abrasive uses, manufacture of abrasive goods, and the production of aluminium), the Government may concede a preference in the selection of mineral lands. It is also provided that the Government shall have power to require that all corundum mined from lands leased under the Regulations shall undergo certain processes of treatment and milling at works to be erected in the Province to prepare it for market; and may further require, from time to time, as circumstances appear to warrant, that works be established in the Province for the manufacture of all useful or commercial products for which the mineral or ore is economically adapted.

NOTES ON PROSPECTING FOR CORUNDUM. BY WILLET G. MILLER, M.A.,
SCHOOL OF MINING, KINGSTON.

(Read 10th December, 1898, in discussion on Mr. Blue's paper.)

When I first received instructions from the Director of the Bureau of Mines to make an examination of the occurrence of corundum in the township of Carlow, reported by Mr. W. F. Ferrier, of the Geological Survey,⁽¹⁾ I was not very enthusiastic over the prospect, especially as I was expected to search for other outcrops of the mineral. The district is situated rather near at hand to the chief cities and older settled parts of the Province, and, moreover, it occurs in a region which has attracted considerable attention from prospectors and miners during the last 35 or 40 years. It thus appeared to me that there could not be very much of the material in place in the district or some one would have noticed its existence years before. However, as my instructions authorized me to make notes on any other economic minerals which might be met with in the field, I thought that if I could not find more corundum I could at least get enough material for a report and spend my time to advantage in directing attention to some of the other numerous ore bodies which are to be found in Eastern Ontario.

For the first week after entering the field the outlook for the discovery of other occurrences of the mineral was not very promising. The district is a rather rough one, and the rocks are covered to a considerable extent by soil and timber, and the part of the field in which we first started to work happens to be cut through by two large river channels. Having once obtained the key to the mode of distribution of the deposits it was chiefly then only a matter of time and work to find other deposits. Drift deposits assisted us much in prospecting. In every case, I think, where we found boulders of rock carrying corundum we found the mineral in place a few miles to the northward in the direction from which the glaciers had come. We also soon became familiar with the different varieties of the rock which belonged to the same magma as the corundum-bearing variety, and knew how these different varieties shaded off into one another and into the corundum-bearing variety. We could generally tell when we were approaching the latter variety from the character of the other rocks. We also, of course, made use of the strike and other characteristics of these rocks.

The work on which we were engaged differed materially from ordinary geological field work. In the latter case one does not need to examine every hundred acres, nor in most cases every square mile or so. A fair outline of the geology of a district can generally be given by following the roads or canoe routes.

In the part of the field in which we worked in 1897 the outcrops of corundum rock occur in isolated areas. This made our work more difficult, as, being engaged in examining lands of which the mineral right in most cases belonged to the Government, we were anxious that no good deposits should escape us. It was as important for the Government to know where these deposits were situated, as it would have been for any private company which might have controlled the lands. A rather foresighted policy had been inaugurated in connection with the corundum

(1) Summary Report Geological Surv., Can., 1896, page 116.

deposits, it having been decided to withdraw from sale the promising areas found by us and thus prevent them getting into the hands of speculators, who might tie up the district for years by asking exorbitant prices. By thus withdrawing these areas from sale it was also made feasible to secure better terms, as to working the deposits, from parties securing them. I feel that under this arrangement our work was of as much direct value to the Province at large as it would have been to any private company had we been engaged by such a concern. Our work has increased the value of these Crown lands by enough to pay many times over the amount expended on the examination. My conscience is, therefore, easy on the financial side of the subject, as the lands could be sold by the Province to-day for much more than they could have been sold for at the time we began the work on them. This ought to satisfy those people who are always asking for direct returns from geological work, and who are often unable to see that practically all geological work has at least an indirect bearing on economic questions.

In our work in 1897 we outlined a belt of country about 30 miles in length and two or three miles in breadth over which outcrops of corundum occur. In our last season's work, 1898, we have succeeded in increasing considerably the length of our belt of corundum rocks, and we have not yet come to the end of it. The rather contorted belt, as we now have traced it out, is over 75 miles in length, and there are two isolated areas of the rock on which I have done some work, but which time has not permitted me to attempt to connect with the main outcrops. One of these lies a considerable distance to the southeast of the eastern end of the main belt and the other area lies to the south of the western end. It might be possible, if one had time, to connect these different areas.

As it now stands, the belt of these rocks holding its irregular and sometimes narrow course through the other members of the Archæan crystalline series is one of the most interesting structures we have. I think I am safe in saying, in our oldest group of rocks. As yet we do not know exactly what this structure signifies. But I hope that when it is carefully worked out and studied in greater detail this group of rocks will aid in solving some of the problems which are now attracting the attention of petrographers.

In the highly metamorphic state in which many of the members of the Archæan occur it is difficult to make certain that igneous rocks, such as granites, syenites and diorites, which are found in isolated outcrops miles apart, belong to one eruption, but in the case of the corundum-bearing rocks we have a mark in the mineral itself which assists us in connecting and proving relationship between masses which would not otherwise have attracted attention as being related.

The corundum, as Mr. Blue has said, occurs typically in what we have called syenite. The rock often contains nepheline, which is the primary reason for speaking of the series as syenite. I have found by microscopical and chemical examination, however, that while the greater part of the rock in which corundum occurs may be called in general syenite, there are large masses of rock, consisting in one case of several square miles, which are more properly called gabbros or anorthosites. On the other hand, the syenite appears in some cases to merge gradually into the quartziferous variety, or into granite, in which, however, no corundum has been found. We have thus as products of one magma a series of plutonic rocks, ranging in acidity from granites to gabbros. And if one likes to make hair-splitting distinctions, he might work out representatives of about all of the plutonic group. I might also add that if there is any man who wishes to gain the questionable distinction of introducing a new rock name, I think he could get material for the purpose among this corundum-bearing series.

The first person to report the occurrence of these rocks, which have since been found to so commonly carry corundum, in the district, was Dr. F. D. Adams. In the summer of 1893 Dr. Adams found nepheline syenite in place in the township

of Dungannon, Hastings county.⁽¹⁾ The mineral sodalite which so often occurs in this rock had been found in the district years before by prospectors. Dr. Adams and his associates outlined the occurrence of nepheline syenite in what were called three separate areas in the township of Dungannon and the adjoining township of Faraday, and an outcrop of the rock was also known in Glamorgan, to the west.⁽²⁾ It was not, however, till October, 1896, that corundum was first found in the district by Mr. Ferrier, and it was not till June or July, 1897, that this mineral was known to be associated in the district with nepheline syenite, which had previously attracted considerable attention on account of its comparatively rare occurrence in most parts of the world and on account of the size of the nepheline individuals and the high percentage of the mineral carried by the rock.

In 1890 Dr. A. P. Coleman published a very interesting paper on the character of some glacial boulders which he had found in the vicinity of Cobourg.⁽³⁾ Among these boulders were some which Dr. Coleman determined to be nepheline syenite. It was, therefore, known at that time that this rock occurred in place somewhere in the region to the north where it has since been found to be so widely distributed.

Although corundum is a mineral of considerable interest scientifically as well as economically, no discovery of it was reported in Canada after Sterry Hunt's discovery of it in the crystalline limestone of North Burgess in the later forties till Ferrier's find was made in the autumn of 1896.

After once having seen the corundum in the nepheline syenite of the township of Raglan, where this association was first found, it seemed to me likely that the mineral would be found to occur in the already known outcrops of the rock in Dungannon and the other two townships to which reference has been made. During 1897 time did not permit of a careful examination of these outcrops, but on the index map of the district published in my report⁽⁴⁾ for that year, I outlined these outcrops and stated that the mineral likely occurred in place in these townships. Work during the past season, 1898, has shown that my predictions were correct, as we found corundum in place at several points in Dungannon and in other townships to the west. Moreover we have found that the previously mentioned areas of nepheline syenite in Dungannon and Faraday are parts of what is practically one continuous band of these rocks, but which is in places very narrow, and, therefore, difficult to follow. We have also traced this band fifteen or twenty miles farther west, and have connected these outcrops with the belt worked out in 1897. The relations of these outcrops and the different parts of the belt which have now been connected are shown on the map which Mr. Blue has exhibited.

Since the work with which I was charged was intended to be primarily of an economic nature, and, therefore, more closely connected with prospecting than with geology proper, I have not paid any more attention to the general geology of the district than what was required to enable us to prospect intelligently for the mineral for which we were in search. Moreover, the working out of the general geology of the district is provided for by the Geological Survey of the Dominion, and it seems to me that the work of the Province should be in the nature of applying information supplied from this source and making use of it in the working out of problems which have a direct economic bearing. We already have a fair general knowledge of the geology of the Province in the districts penetrated by and surrounded by our railroads, but the discovery at this late day of an occurrence of a mineral of economic value over such a large area in one of what may be called the older mining and prospected districts shows the possibilities there are of finding other economic products in our well-known mineral districts.

(1) *Amr. Jr. Science*, 1894, and *Annual Report Geological Surv., Can.*, vol. vi. (N.S.)

(2) *Summary Report Geological Sur., Can.*, 1896, vol. 50 A.

(3) *Trans. Roy. Soc., Can.*, 1890.

(4) Part III., 7th Report Bureau of Mines, Ontario.

We now know of the occurrence of a sufficient number of deposits of corundum to offer anyone desiring to work them considerable choice as to location. I have always been careful not to try to "boom" these deposits, as the abrasive industry is a very complicated one, and it cannot be well foretold what success would be met with on working the deposits. In any case I do not expect to see any corundum millionaires, but I believe there is a fair chance of an industry being established which would be a great benefit to the district in which the deposits are situated. The question of using corundum economically as an ore of aluminium is as yet an open one, and can probably only be settled by a series of prolonged experiments.

I brought with me a specimen or two of another mineral which we found in the field while searching for corundum. This mineral belongs to the comparatively rare columbate group, and as it is the first time one of these minerals has been found in Ontario I thought some of the members of the Institute might be interested in seeing specimens.

I have to thank Mr. Blue for the encouragement and assistance which he has ever been ready to give me during the progress of the work. That the energetic manner in which the development of the mineral industries of the Province has been carried on during the past seven or eight years, the time during which the Bureau of Mines has been in existence, is appreciated abroad is evident from a letter which I received a short time ago from one of the most prominent mining men in Eastern Canada. The writer of that letter made this statement:—"The policy which Ontario has adopted with regard to the acquiring of information respecting her minerals and the publishing promptly of reliable reports is a lesson to us which many of us here have been hoping might be copied in our Province."

And now I have to thank you, Mr. President, and the members of the Institute for the privilege you have afforded me, a non-member, of addressing these remarks to you. Since my student days in this city I have had cause to appreciate the encouragement which the Canadian Institute has offered to workers in science throughout the Province. I read some time ago an account of the plan which Mr. Bain has laid before the members of this Institute for the establishment of a Provincial reference library. I hope to see this plan carried out in its entirety, and it will be found it will receive the enthusiastic support of those of us who are interested in science and who live at a distance from the Provincial capital. When this library is established students of science throughout Ontario will be under a still further debt of gratitude to the Canadian Institute, which has now for so many years served as the centre of scientific thought in the Province.

THE INTERNATIONAL SCIENTIFIC CATALOGUE. BY JAMES BAIN, JR.

(Read 17th December, 1898.)

The discussion of the subject of a Scientific Catalogue is singularly appropriate in the Institute at this time, when the Library is being placed on a new footing and arranged for scientific work. The fifty years which have elapsed since the formation of this Institute have witnessed the establishment of an enormous number of similar societies, specializing their scope more and more, until few departments of scientific work are without their organization and printed transactions. It is estimated that there are now published, more or less regularly, 30,000 scientific journals, partly the production of 565 medical and 6,000 scientific societies, and partly published independently. The total number of papers included in these journals, transactions and memoirs is further estimated at 600,000 annually, or an issue of nearly 2,000 per day.

The reasons for the immense increase in this class of publication are not hard to find, and give no indications of a decrease in the immediate future. They are, first, the increasing number of abstruse, valuable papers, which journals dependent on subscriptions cannot see their way to print. These can only be of value to the few, and as scientific men are, as a rule, not wealthy, they are glad to get either the assistance of some society or direct aid from Government. This, freely given, has encouraged the development of memoirs in pure science. Secondly, our universities have so largely adopted the system of post-graduate courses, in which each graduate is encouraged to produce his thesis, and which are published under the name of university studies. And, thirdly, because science has become so specialized that men engaged on minute portions of the work are drawn together to support a special journal where their discoveries and discussions may be certain of a small but appreciative audience.

It is quite evident that no person is able to follow all the scientific publications of the day, even when restricted to one of the great divisions, and that the necessity exists for some means of obtaining a knowledge of at least the titles of those published within a fixed period, and that the catalogue produced by any one society would be both imperfect and expensive. Let us take the Canadian Institute Library as an illustration of what can be done with limited means. We have, in addition to the unbound Transactions, about 8,000 bound volumes, containing on an average twenty papers each. These would require, with a single entry under the author's name, 160,000 entries. An average cataloguer cannot do more than thirty per hour, if allowance be made for all necessary stoppages. This, at seven hours per day, is 210, which, divided into 160,000, gives as the time required for the completion 762 days, or, allowing for holidays, nearly three years. But every student knows that an author's catalogue is only of partial value, and that it must be supplemented by a subject catalogue. This, then, doubles the period, and shows the impossibility of doing such a work single-handed. Many of the older societies, such as the Royal, Antiquarian, Civil Engineers, or Archaeological, have, at intervals of 25 or 50 years, printed an index volume to their publications; but the number of these and the long intervals at which they appear, render them useless for the ordinary student. Practical men have seen that the only escape from the difficulty was by co-operation in a joint catalogue. Professor Henry, Secretary of the Smithsonian Institution, was the first to propose a combined catalogue, in 1847.

and, following out the same suggestion, the Royal Society of London, in 1857, commenced the publication of the catalogue which bears its name and now comprises eleven volumes. After much negotiation, representatives from all of the civilized nations were invited to attend a meeting of the International Catalogue Conference, in London, on July 14, 1896. Sir John Gorst was called to the chair, and, after expressing his pleasure at meeting so many representatives of science, said: "Discussions have always been going on as to the best way of extending the catalogue, and of carrying it out in such a way as to make it supply the needs of scientific workers generally. About three years ago a Committee was appointed specially to take into consideration what appeared to be the only way of carrying out such a work in the future, viz.: to consider the preparation of such catalogues by international co-operation. The Royal Society realized from a very early period that it could not itself undertake such a work—that no single body could undertake it; and therefore invited the opinions of scientific men and scientific institutions all over the world. There was practically but one reply—that such catalogues were essential—and there was practically no doubt that the only way of carrying out the work was by international co-operation. The Royal Society worked at the subject during two years, and eventually this Conference was summoned at its instance, through the aid of Her Majesty's Government. If any proof were required of the importance of the work, I think the fact that this meeting is attended by so highly representative a body of delegates is in itself sufficient. . . . The great object before us is to produce a catalogue available for use by scientific investigators throughout the world. It is a mere bibliographic work that we are seeking to perfect. We desire to produce catalogues, arranged not merely according to authors' names, but catalogues arranged also according to subject-matter; and a very large number of those who have considered the subject are of opinion that in these catalogues the subject matter must be classified not merely broadly, so as to deal separately with individual sciences, but much more in detail, so as to deal with sections of individual sciences, in order to meet the wants of specialists. Each index, therefore, must be a classified subject index; and many of us also believe that it must be an analytical classified subject index—that we must go beyond the mere titles of papers and consider the subject matter, so that such information is placed in our hands that we shall know practically what is in a paper wherever it may be published. . . . But with regard to details—and there must be many details in working out such a scheme, especially when we come to consider questions of classification—it is quite clear that at this meeting we cannot do more than discuss broad principles. The details must be considered by committees, appointed either by this meeting, or by means of machinery set in action by this meeting. And in order that there should be a full study of all these questions, the Royal Society has proposed that the catalogue shall not commence until the year 1900. We have suggested that at least four years should be given to the preliminary work of organization. If means can be devised of leading authors, societies, and publishing bodies generally to co-operate in this work, it is clear that the central organization will exercise almost mechanical functions: it will, so to speak, sit at the receipt of custom; it will see that the scheme is carried out in a uniform way, but the material it requires will flow naturally towards it. In this way much will be done to economise both time and money. Later in the Conference, when we are clear what is the nature of the work to be done, it will be very important to consider what part each contributing country shall take in the enterprise in supporting it financially."

The Conference sat for four days, and agreed upon a basis of international work. English, French, German, and Italian were declared to be official languages, and resolutions were received in any of these. In printing the catalogue, it was resolved, "That English be the language of the two catalogues, authors' names and titles being given only in the original languages, except when these belonged to a category to be determined by the International Council."

The preparation of the catalogue is to be in charge of an International Council, to be appointed, and the final editing and publication shall be conducted by a Central International Bureau, under the direction of the International Council. Any country that is willing to do so shall be entrusted with the task of collecting, provisionally classifying, and transmitting to the Central Bureau, in accordance with rules laid down by the International Council, all the entries belonging to the scientific literature of that country. "In indexing according to subject-matter regard shall be had, not only to the title (of a paper or book), but also to the nature of the contents."

The catalogue shall comprise all published original contributions—periodical articles, pamphlets, memoirs, etc.—to the mathematical, physical, or natural sciences, "such as, for example, mathematics, astronomy, physics, chemistry, mineralogy, geology, botany, mathematical and physical geography, zoology, anatomy, physiology, general and experimental pathology, experimental psychology and anthropology, to the exclusion of what are sometimes called the applied sciences—the limits of the several sciences to be determined hereafter."

The system of collecting and preparing material for the catalogue in each country shall be subject to the approval of the International Council.

"The Central Bureau shall issue the catalogue in the form of 'slips' or 'cards,' the details of the cards to be hereafter determined and the issue to take place as promptly as possible. Cards corresponding to any one or more branches of science, or to sections of such sciences, shall be supplied separately at the discretion and under the direction of the Central Bureau. The Central Bureau shall also issue the catalogue in book form from time to time, the entries being classified according to the rules to be hereafter determined. The issue in the book form shall be in parts corresponding to the several branches of science, the several parts being supplied separately, at the discretion and under the direction of the Central Bureau."

It was also decided that the Central Bureau shall be located in London, and that the Royal Society appoint a Committee to study all undecided questions relating to the catalogue and to report later. As it was thought that the necessary guarantee fund could be raised by private subscription, it was decided that no appeal to the Governments of the several countries represented was necessary.

At the adjourned meeting, which took place in October, 1898, the above was confirmed, with some slight alterations. The first of January, 1900, was fixed as the date for beginning the new catalogue, and the recommendation of the Royal Society was adopted, that, "In 1905, in 1910, and every tenth year afterwards, an International Convention shall be held in London to reconsider, and, if necessary, revise the regulations for the carrying out of the work of the catalogue."

THE TORONTO MAGNETIC OBSERVATORY. BY R. F. STUPART, DIRECTOR.

(Read January 14th, 1899.)

On the recommendation of the Royal Society and the British Association the British Government determined in 1840 to establish a fixed Magnetic Observatory in Canada, and it was decided that it should be placed under the general supervision of the Ordnance Department of the Army. Arrangements having been completed, Lieutenant Charles James Buchanan Riddell, R.A., was selected for duty in Canada. Leaving his detachment, consisting of four non-commissioned officers of the artillery to embark with the instruments on a vessel bound direct to Quebec, he proceeded himself to Canada by the more expeditious route of the United States. Having waited on the Governor-General at Montreal to present a letter of introduction with which he had been furnished by the Master-General of Ordnance, and having communicated with the commanding engineer, to whom he was the bearer of instructions and authority to build an Observatory, he proceeded to examine different localities which were suggested as convenient sites. The preference was finally given to Toronto, where a grant of two and a half acres of land belonging to the University of King's College was offered by the Council of the University. The first Observatory building was of logs, rough cast on the outside and plastered on the inside; it was completed during the summer of 1840, and the observations were begun in September. The operation of the Observatory as an Imperial establishment was brought to a close in the early part of the year 1853, and was resumed under the authority of the Provincial Government in July of the same year.

In the autumn of 1853 the present Observatory was commenced, to take the place of the old building. Very great care was taken during construction to insure freedom from magnetism in all the stone used, and all nails and fastenings were of either copper or zinc. For twenty-three years the position of the Observatory was, as far as known, faultless; observations were carried on systematically and carefully, and results were given to the scientific world which, with those obtained under the old military régime, have made the Toronto Observatory famous in the history of Terrestrial Magnetism.

In 1876, however, trouble began with the erection of buildings close to the Observatory, causing some very small changes in zero values. Then followed a few years later electric light circuits, which produced a change in the force instruments whenever the currents were turned on and off; this difficulty was in part overcome by the Light Company courteously agreeing to arrange their wires in the vicinity of the Observatory in such a manner that the currents would counteract each other. The next difficulty occurred when a large addition was made to the neighbouring buildings before mentioned, tons of iron were used in construction in all too

close proximity to the magnetic instruments, and much time and labor have been required to determine the precise effect of this "iron mine" on the various instruments. It was not, however, until the autumn of 1892, when the trolleys began to run, that we began to suspect that sooner or later the Magnetic Observatory would have to be removed to another site.

The magnetic instruments in the Observatory consisted of those brought out by Lieutenant Riddell in 1840, of which eye readings have been taken six times each day, and of another set of instruments, consisting of a bifilar for the measurement of the horizontal component, and a balance needle for the vertical force, and a declinometer, all of which record photographically.

Electric cars first ran in Toronto on August 17th, 1892. The line first put in operation was that on Church Street, which was followed on September 5th, by one on King Street, between George and Dufferin Streets. During the first few weeks, while a very small vibration of the needle was discernible on the V. F. curve, it was generally almost inappreciable, and it was not until September 20th that the movement increased to an extent sufficient to really impair the value of our magnetic curves. A marked increase of current must have been used on that day and afterwards. On October 10th the cars first ran on Yonge Street, and there was only a very small increase in the vibration, but a decrease of about .000070 of a dyne was observed when the current was on.

About 10 a.m., January 14th, there was a marked increase of vibration, and the vertical force increased about .000200 of one dyne. This disturbed period was only temporary, and shortly after 5 p.m. on the 17th there was a reversal to the smaller vibrations. This continued until May 15th, when larger vibrations began again, and continued with varying intensity during the summer, while the decrease of the vibration with the current ranged from about .000200 to .000500. This disturbance was very great between September 12th and October 17th, and at intervals during the following year; but there was no radical change in conditions until December 17th, 1894, when a decrease of V.F., while the current was on, was changed to an increase, this occurring when the cars first ran on McCaul St. Throughout 1895 the vibration and amount of permanent deflection was very nearly as it has been since; but on October 15th, the increase of V.F. with the current was again changed to a decrease, this occurring at the time that the railway company made certain changes in the feed wires. It is noticeable that, although several changes occurred in the V.F., it at times having been less with the current on and at other times greater, the horizontal force showed a decrease on all occasions with the turn on of the current. This decrease during the past two years was .000200 to .000500 of a dyne. No appreciable deflection of the declinometer magnet was noted, the only effect being a continuous vibration, which rendered the curves very ragged and difficult to read with accuracy.

A study of the traces during the times that the various electric lines were put in operation, showed that, with the currents ordinarily used, there was little effect at three-quarters of a mile, and a further survey with a portable instrument afforded further evidence in the same direction.

Before definitely recommending that the Magnetic Observatory should be removed from Toronto, the Director wrote to various well-known magneticians, present at the meeting of the British Association in August, 1897, requesting the favour of their presence at the Observatory to inspect the photographic magnetic curves there obtained with the view of expressing an opinion as to the advisability of continuing the records at the present site, or of removal to some point distant from electric tramways. Professor Rücker, F.R.S., Professor Carey Foster, F.R.S., Professor Fitzgerald, F.R.S., Dr. Van Rijkevorsel, and Professor Frank Bigelow, were the gentlemen who courteously accepted the invitation, and were pleased to sign a statement that, in their opinion, the value of the magnetic observations at Toronto had been seriously impaired by the trolley system, and advised removal to some other site.

It then having been decided to remove the Observatory, a point was chosen nine miles northeast of the former Magnetic Observatory, latitude $43^{\circ} 47' N.$, longitude $79^{\circ} 16' W.$, easily accessible by railway, and yet very unlikely to be invaded by the trolley system. At present there is no electric railway within seven miles, and little prospect of one within five miles for many years.

The new Observatory, which was commenced in June, and finished during the early days of September, consists of two parts—a circular stone cellar and an above ground structure. The cellar is nineteen feet in diameter, the walls two feet in thickness, the floor concrete, and the roof covered with felt and gravel, in which, on stone piers sunk in concrete to a depth of six feet below the floor, are placed the self-recording photographic instruments: namely, the declinometer for recording changes in the direction of the magnetic needle, and the bifilar and vertical force instruments for registering, respectively, changes in the horizontal and vertical components of the earth's magnetism. Above ground and connected with the Observatory by a flight of steps, is an erection which is divided into two portions, in the larger of which absolute magnetic determination will be made, piers being provided on which to place the necessary instruments, and an adjustable opening on the roof for transit work; the smaller portion is an office, which will be heated by a copper stove.

Observations were first made in the new Observatory on September 10th, and by Oct. 1st all the instruments had been adjusted in their new position, and everything was running smoothly. Results already obtained show that values will differ but slightly from those obtained at the old Observatory, and a very careful comparison was made before dismounting the old eye-reading instruments in Toronto.

Very great care was taken in selecting materials for the building. Every stone used was tested for magnetic effect, and none but copper and zinc nails and fastenings have been used.

There appears to be every prospect that the new Observatory will be admirably suited for the purpose for which it was designed, and there is strong reason to think that the series of observations at Agincourt will be practically a continuation of the old and valuable series of observations made in Toronto. All photographic records will be sent for development to the Toronto Observatory, which continues to be the central office of the Meteorological Service of Canada.

THE GREAT SUN-SPOT OF SEPTEMBER AND OCTOBER, 1898. BY ANDREW ELVINS.

(Read February 18th, 1899.)

The present year has furnished us with one of the finest groups of sun-spots which I have ever observed; it has attracted the attention of observers throughout the world, and I have thought, that as I observed, and made drawings of it on each day when clouds did not render observation impossible, it might be of sufficient importance to bring it before the Institute.

The spot must have been on the eastern limb a day or more before I saw it. My first observation was on the 4th when it was inside the limb a day, or perhaps two days distance. I was struck by its large size, and the black umbra, and as I thought it would be an important spot I sketched it. On the 5th the umbra was seen to be composed of four parts; (*as some think*), formed by the photosphere throwing portions of itself across the dark umbra which is regarded lower than the photosphere; such divisions called "bridges" or "tongues" are seen in nearly all large spots. I think they are breaks or divisions in matter lying on, or above the photosphere; which permit the photosphere to be seen through the openings or breaks.

The spot had a small spot on the north preceding side very near the penumbra of the large spot, two or three on the north following side, also very near or joined to the penumbra of the large spot, and also two following between the spot and the limb.

On the 7th the umbra was greatly changed; I could only see three dark umbra divisions instead of four, the two small groups which followed on the 5th had become much larger and contained many black points in a penumbral shading which enclosed the whole.

On the 8th the three umbras had disappeared, and one large black mass existed in the large oval penumbra, the north preceding spot was more distant from the penumbra of the large one than on the 7th, and all the following spots in the train had become larger and more distinct; there were also fragments of penumbra, scattered through the intervals between the trains, larger spots, and a number of black points on the photosphere too small to show any details.

Being near the sun's central meridian I estimated its size in the following manner, roughly of course, but not far from the reality.

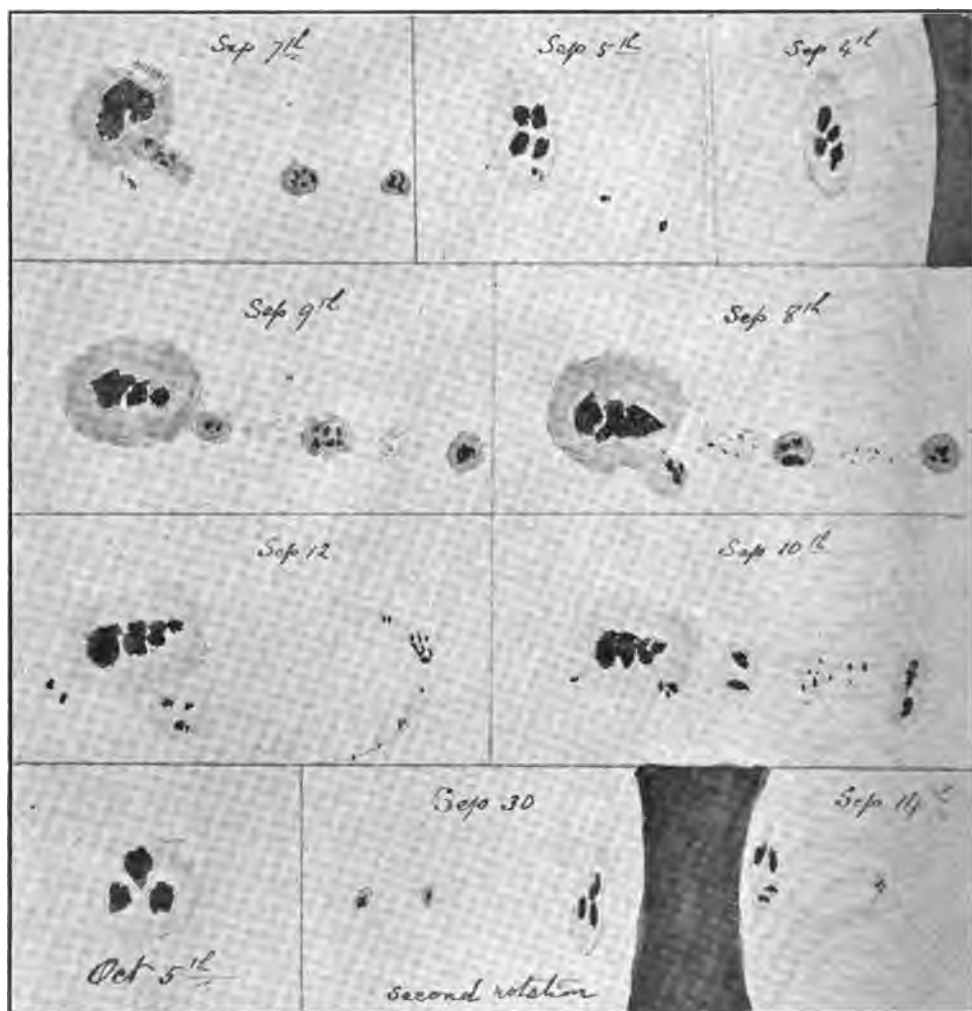
Sun's diameter 800,000 miles, length of group one-sixth ($\frac{1}{6}$) of sun's diameter, = 130,000 miles, large spot about one-third of the length of group, equal 43,000 miles.

An extract from a letter written September 9th by Prof. David E. Hadden will throw additional light just here.

"When I first observed this spot, but a mere line of light separated it from the edge of the limb, no penumbra being visible except on the north and south edges of the long umbral line, (a bright aurora was seen the same evening.) On the following day penumbra was visible on all sides of the umbra, . . . the changes from day to day were quite marked. Owing to atmospheric conditions the spectroscope could not be used until the 6th, when but little or no disturbance could be noticed in the vicinity of the spot. On the 7th though, a sudden outburst occurred. When the spectroscope was adjusted at 11.40 a.m. central time, the entire region just preceding, and for some distance following, the spot was greatly agitated, the H_{α} line being reversed and distorted, small black jets projecting from each side of the line were noted in several places, and on opening the slit slightly, the flame and spike-like figure of the disturbance could be clearly seen. At 12 noon, intensely brilliant flames were observed over the large spot extruding from the umbra to the umbra to the edge of the penumbra on the east side. This phenomenon was particularly striking—the intensely bright scarlet flame nearly in the centre of the dark absorption band of the spot spectrum being very interesting; the D_{β} line was bright,

and D_1 and D_2 and many other lines widened. At 12.05 p.m. a small dark line attached to the H_α line extended obliquely toward the red end of the spectrum in the region just preceding the main spot. At 1.40 p.m., the entire disturbance had almost ceased."

September 9th.—The central spot in the train seems to be nearer the large spot than on the 8th, and the nuclei in all have kept changing; many fine black points are still visible along the line of the train.



September 10th.—The central spot in the train has moved onward and is now quite near the large spot. I think the spots must be situated at different depths in the solar atmosphere, and be moved by currents moving at different rates. Perhaps a cyclonic motion in a vertical plane nearly parallel with the sun's equator might best explain the motion.

I was not able to get a sketch on the 11th and I much regret it, for two sketches made on the 12th are very remarkable. The central group which was nearing the large spot on the 10th, has quite disappeared; has it ceased to exist?

or has it passed beneath the great spot and been eclipsed by it, or in some way mingled with it?

I hope photographs which have doubtless been taken will answer these questions.

On the 14th it was bad seeing but I made a rough sketch; the large spot was near the limb, one part of the penumbra was on it and only one spot could be seen following it; it probably passed over the limb on the 16th which was just fourteen days crossing the disc, and it came on on the 2nd.

The motion of the earth in its orbit adds about two days to the time which the sun's rotation alone would require to enable us to see a spot which is on either limb of the sun until it returns there again, about twenty-seven days together, and as this spot was on the east limb on the 2nd, it should be there again on the 29th. It appeared at the proper time but greatly decreased in size, and quite shorn of the fine train of spots seen when it was last visible.

Two spots, however, preceded it; the first must have been on the limb on the 27th. I saw it on the 28th and stated in a letter that the large spot had returned; I was mistaken in this, it was too early; the great spot was on the limb on the 29th and my first sketches were made on the 30th.

But the smaller spots which preceded it may have special interest. We noticed the fact that the spots in the train following the large one when it was last seen approached the large spot and seemed to coalesce with or pass beneath or above it, and it is possible that the spots which followed it, may precede it now; if the westward motion continued during the fourteen days when they were invisible to us they would have passed to where we see them now.

On October 1st the great spot was well in on the disc; it contained three pretty round black umbras and the penumbra was nearly circular, and two spots preceded it, the foremost one the largest.

From this time the size and activity of the spot gradually diminished, though occasionally very bright bridges, and bright points were seen. On the 6th the three umbras divided, and on the 8th four were plainly visible, the spaces between them being intensely white. I saw it last on October 10th, near the western limb; it was cloudy on the 11th and on the 12th it had disappeared.

I should note that the small spot preceding became more widely separated as time passed on.

I wish to state here as I have often stated before, that I see no evidence in this spot of spots being deep hollows in the photosphere; the drifting of the groups in the train in September toward the large spot, and the drifting of the spot preceding it in October, from the large spot render it far more probable that dark matter floating and drifting in the sun's atmosphere cuts off the light of the photosphere below, and is seen by us as a spot.

It is more than twenty years ago since I called the attention of this Institute to the influence exerted by sun-spots on the earth and its atmosphere. Prof. Loomis of Yale was working at that time on the subject, and had shown that *magnetic disturbances* and our *auroras* are more numerous when sun-spots are numerous than at other times; but whether they were directly influenced by solar disturbances, or are caused by cosmical conditions which affect both earth and sun was by no means certain. In the case of the present spot there has been a very marked magnetic disturbance just as the spot passed the central solar meridian, and at the same time, September 9th, brilliant auroras were seen in Europe, and also very generally through the Dominion of Canada.

Dr. Vedder and Mr. Shearman have noticed auroras and magnetic storms, when spots were near the eastern limb of the sun; European observers have noted such displays when the spots were on the sun's central meridian.

In the case of this spot, in Canada auroras were reported from thirteen stations on the 2nd of September, and from twenty-one on the 9th, and again on the 28th and 29th, when the spot had made one complete revolution and was again on the east limb, auroras were reported from many stations. So in this instance we have a plus of auroras when the spot was on the eastern limb and also when near the centre, whilst very few are reported at other dates. In this case both the American and European observers may be right as to the facts; and our theories of the cause of the coincidence will have to include both.

But it is just here that we have found the record of the disturbance of the magnetic needle of great importance ; for the photographic tracing of the Toronto Observatory, which Mr. Stupart has placed at the service of Mr. Harvey and myself, shows a great disturbance just at the time when the spot crossed the central meridian of the sun. This shows, (or at present seems to show) that the solar energy passes *radially* from the sun to the earth, and that the outbreak of spots causes an *immediate* transmission of energy through the solar system.

I long ago called the attention of this Institute to the fact that HURRICANES have been far more numerous near the period of sun-spot maxima, than minima. This is so true that taking the four years near the maximum, we find more than double the number of occasions when the wind moves more than thirty miles per hour at Toronto than we get in the same number of years at sun-spot minimum.

The spot of September, 1898, broke out during the minimum period, and this enables us to trace the coincidences with a better chance of seeing and detecting *real connections* from chance coincidences than at a time of spot maximum.

In this connection it may be of some importance to notice the fact that a terrific hurricane swept the Windward Islands on September 10th, just the time when the spot was crossing or very near the central meridian, and we also had a most destructive tornado in the Niagara district when the spot was on the eastern limb or near it.

It has been found that as a rule spots at the commencement of a new cycle are far from the solar equator, and that they gradually approached the equator and were as a rule near it at maximum. The spot of September was, however, near the equator, though we must be near the minimum of the sun-spot period.

THE OCCURRENCE OF GOLD IN SOME ROCKS IN WESTERN ONTARIO. BY
J. W. BAIN, ESQ.

(Read April 22nd, 1899).

Of many speculations on the origin of metalliferous lodes, perhaps none has attracted more attention than that which is known as the theory of lateral secretion, and the object of this note is to discuss in brief its possible application to some ore deposits of Western Ontario.

Delius in 1770 and Gerhardt in 1781 concluded that rain penetrated the earth, taking up any soluble material in its path, and, afterwards collecting in the fissures and cavities, gradually deposited the dissolved matter with the formation of a metalliferous lode. This is a fair description in general terms of the theory of lateral secretion, and for the next ninety years the idea lay fallow. In 1873, Sandberger in Germany commenced a series of investigations for the purpose of determining whether the theory were tenable, and the ores, veinstones, and country rocks of a number of veins, were subjected to careful analysis, particular pains being taken to detect and estimate small quantities of certain elements. The hornblende, augite, olivine and mica of the rocks were isolated, and in them could be detected appreciable quantities of almost all the elements commonly occurring in metalliferous veins. Space will not permit of any lengthened description of these interesting researches, which resulted in the author's adoption of the theory, but attention may be directed for a moment to the United States, where steps were being taken to collect evidence upon the subject. Geo. F. Becker was commissioned by the Geological Survey to examine the Comstock Lode, and during the work an investigation similar to Sandberger's, though on a much smaller scale, was carried on. The results which were published in 1882 led the geologist to the belief that lateral secretion would satisfactorily account for the origin of the lode.

J. S. Curtis, reporting on the Silver Lead deposits of Eureka, Nevada, concluded that the theory was capable of explaining the origin of these ore bodies also, and S. F. Emmons, in a monograph on the Geology and Mining Industry of Leadville, Col., describes some experiments which led to a similar view.

These opinions were witnessed by an array of analytical results, which dealt almost entirely with gold and silver, gold being determined only qualitatively. In view of these facts, it was decided to make some investigations upon Ontario ores. The methods were rendered as accurate as possible, and, although they differ somewhat from others which have been used, the changes were confined to details, with, it is believed, beneficial results.

The samples examined were country rocks, taken from 6 to 10 feet distant from the vein; the following are the results:

Foley mine—gold.	6c. to 17c. per ton.
Mikado " "	12c. to 28c. " "
Regina " "	3c. " "
Sultana " "	none.
Granite, protogene, at least 500 feet from any vein—gold	none.

In endeavouring to estimate the value of these results, it must be remembered that more than one interpretation may be placed upon them. If we assume that the mineral-bearing solution can permeate the rock with a certain degree of freedom, and this premise is one which we can make with confidence, solutions from underground sources capable of depositing minerals would impregnate the country rock for some distance and produce a condition, close to the vein, resembling that which would result from lateral secretion. For this reason, a series of samples taken at points increasingly remote from the deposit, would yield results of much value, if it were possible to estimate with great precision the amount of gold

and silver in each. This, unfortunately, is a difficult task ; the amount of silver present in the rocks and gold ores of Western Ontario is comparatively small, and the determinations are not sufficiently exact, in that case, to inspire confidence ; while the amount of gold is often many times less than that which is commonly reported by assayers as a trace. In addition to this, the examination of the samples is tedious, and the limited time at my disposal was only sufficient for the attainment of the results above mentioned ; it is almost superfluous to add that in such questions as this, the evidence can not be too abundant, and should as a minimum comprise many times the number of results which have been stated.

It is too soon yet to arrive at any definite conclusion, but we may state as a step towards the final result, that certain country rocks in our western mining district contain small but determinable quantities of gold.

COLONEL MAHLON BURWELL, LAND SURVEYOR. BY ARCHIBALD BLUE, DIRECTOR OF THE BUREAU OF MINES, TORONTO.

(Read April 22nd, 1899).

I have read all the letters and journals of Mahlon Burwell to be found on the shelves and in the vaults of the Surveys office of the Crown Lands Department, and if in the use of them I were to follow the example of Carlyle in his *Oliver Cromwell* I would make a large book. But Burwell has been dead only a little more than fifty years, and his journals and letters have not yet attained a richness



MAHLON BURWELL.
(From an Oil Painting).

of age, not even those of ninety years ago. The paper is but slightly yellowed, the ink is but faintly faded, and the penmanship is neat and flowing. I was going to say that they are as legible as if written yesterday, but that would be an odious comparison in view of the fact that in our time and in our own city good writing, like spelling and reading, has gone out of fashion, if it has not become a lost art. By the end of the twentieth century the old records of the Crown Lands Department will begin to have value, and if the Burwell papers are preserved until then some writer on Canada in the Nineteenth Century will find them out and make them live again in history. But will they be preserved? A few of the letters and more than one-half of the journals are already missing from their place, as a consequence, I have no doubt, of a lack of motive to keep the records of the office complete, and of the frequent movings of the seat of Government during the years of the Union of Upper and Lower Canada—to Kingston, to Montreal, to Toronto, to Quebec and to Ottawa.

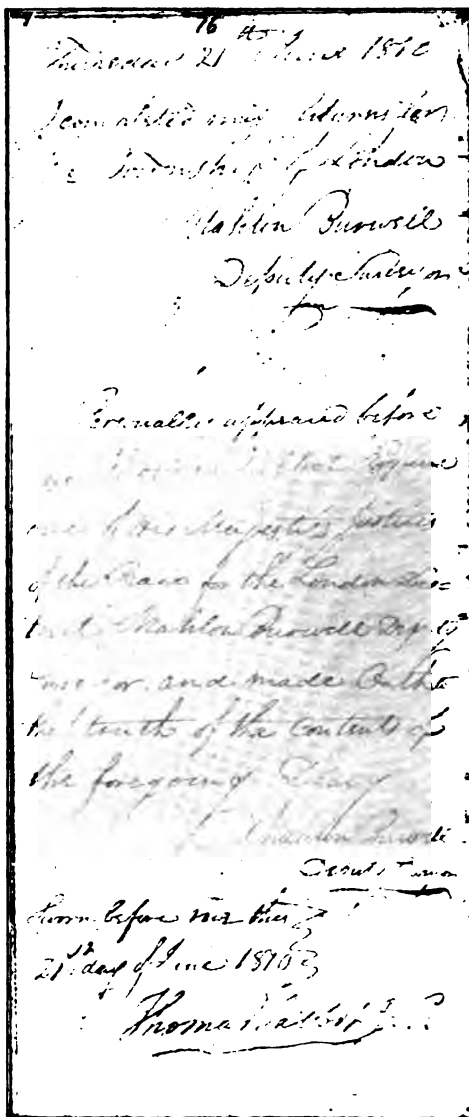
I am to write of Mahlon Burwell as a Land Surveyor, and therefore I shall say little upon other matters in which as a man active in affairs he took some part. The letters and journals indeed deal closely with the business he had in hand, and only at rare intervals is there a gleam of personal or human interest to lighten up the official soberness. I shall make two or three lengthy quotations from the official instructions and from the journals, to illustrate the methods of ninety years ago, and how difficulties were faced, and how work was done as the methods required. Those were days of military ideas in Canada, and men of the Civil Service, outside as well as inside, discharged their duties with the courage and precision begotten of military discipline. They were not all exemplary men in the highest ranks. Some took advantage of their opportunities, seeking especially to enrich themselves by securing valuable tracts of the public lands either as gifts from the Crown's representative whose favorites they were, or by paying for them at a nominal price; and the Crown's representative himself was not always a man above suspicion. But in the case of Mahlon Burwell I have not discovered the suggestion of an improper act. He appears throughout all the papers and letters as a modest, faithful servant, and as a dignified and highminded man.

It has been said of Queen Victoria that she reigns but does not govern. This could not be said of the Governors of Canada in the days before responsible government, when George the Third was King. Francis Gore, who was Governor

of Upper Canada from 1808 to 1816, was every inch a Governor, and the administration of the country was in his hands down almost to the smallest detail. He kept a watchful eye upon the public domain, and, following the good example set by Simcoe, he sought diligently to promote its settlement.

In May, 1803, Col. Thomas Talbot commenced the settlement known by his name on the shores of lake Erie, in what is now Elgin county. Next year an expenditure of £250 currency was made under his direction in building a road through his lands. When Gore became Governor a memorial was addressed to him by Talbot, praying for a plan of settlement similar to the one adopted in the formation of Yonge street, which in Talbot's opinion would result in completing the road to the full extent of the first intention. The matter was referred to the Executive Council, who reported to the Governor that the district to be served by the proposed road was very thinly inhabited, that in no other part of the Province was the want of facility of intercourse more sensibly felt and experienced, and that the money already expended would be entirely lost to the public if the design of continuing the road was frustrated. Besides, it was felt that a highway extending through the country and occupied by a good class of settlers would add to the value of the large adjoining block of land which had been set apart in Southwold, Yarmouth and Houghton as the source of a fund for public schools. It was therefore advised that a grant of lots of 200 acres should be made to persons willing to become settlers on each side of the projected road, subject to these conditions, viz: (1) That within two years from the time each settler was permitted to occupy a lot he should build thereon a good and sufficient dwelling house of at least 15 by 20 feet in the clear, and occupy it in person or by a substantial tenant. (2) That within the same time he should clear and fence ten acres, and clear and open up one-half of the width of road in front of his lot, and cut down all trees within a hundred feet of the road. But as the lots proposed to be granted under this scheme were parts of the lands set apart for public schools, it was recommended that land of equal extent and value should be appropriated elsewhere for the same object.

The office of Surveyor General was vacant at this time, and was occupied by Messrs. Chewett and Ridout as acting Surveyors General.* They were commanded



A PAGE FROM THE LONDON TOWNSHIP JOURNAL.
 Reduced to $\frac{2}{3}$ size.

*December 26th, 1810, Secretary William Halton was commanded by the Lieutenant Governor to inform Thomas Ridout, Esquire, Surveyor General, that he had been pleased to appoint William Chewett, Esquire, to be first clerk in the Surveyor General's office from the first of July last, in the room of Mr. Ridout himself, promoted to the office of Surveyor General from the same date. Mr. Ridout held the place about eighteen years, and again Mr. Chewett became acting Surveyor General, but he never attained the full rank.

by the Lieutenant-Governor—his orders were always in the form of commands—to send a surveying party into the London District to survey and lay out the new road, and upon the recommendation of Col. Talbot the post of surveyor was offered to Mahlon Burwell, being his first commission from the Government. The instructions, under date of March 24th, 1809, were in the following terms:

“In obedience to His Excellency, the Lieutenant-Governor’s commands to us, bearing date the 17th February, 1809, to send a surveyor and a sufficient party, as soon as the season will permit, to complete certain surveys in the London District recommended by the Executive Council and approved by His Excellency the Lieutenant Governor, upon a petition submitted to the Board from Thomas Talbot, Esq., of Port Talbot, who has recommended you to carry the said survey into execution.

“You are hereby required and directed without loss of time, as soon as the season will permit, to survey and lay out a road to pass through the aforesaid townships upon the principle of Yonge street, by making the said road in breadth one Gunther’s chain, and laying out lots thereon of 20 chains in breadth on each side of the same, leaving a road on the side lines of each of the said townships, and a road between every five lots in each of the same, of one Gunther’s chain.

“For this survey your pay will be 7/6 per day, with an allowance in lieu of rations of 1/3 Provincial currency per day.

“Your party is to consist of eight men, that is to say, two chainbearers and six axe men only, considering the country through which you have to pass is lightly wooded, by having little or no underbrush.

“The chainbearers will be allowed 2/- per man per day. The axemen will be allowed 1/6 per man per day, all Provincial currency, and you will be allowed for each ration furnished to your party 1/3 Provincial currency per man per day.

“The ration to be of the following species, viz., 1½ lb. flour, ¾ lb. of pork and ½ pint of peas.

“You are to understand that this allowance to you of 1/3 Provincial currency per man per day for each ration is to cover all expenses whatsoever, such as transport, bateau hire, camp kettles, axes, tommyhawks, tents, bags, snowshoes, etc.

“The chainbearers must be sworn to the faithful discharge of their trust before they enter upon their operation. This you are authorized to do yourself, under an Act of the Province of Quebec, no law in the Province of Upper Canada having been made to the contrary; but it will appear more solemn and have a better effect to have it performed by a magistrate.

“The whole of your party, being eight in number, are actually to be employed in the field without any subterfuge, as you will be obliged to make oath to this fact. But should you not be able to engage the whole of your party—that is to say eight men, including axemen and chainbearers—you are to bear no more men on your pay list than those who are actually employed in the field.

“Should you be under the necessity of discharging any of your party before the survey is completed, you must keep four open pay lists for that purpose, which the person so discharged must sign, whose signature must be witnessed by some person of respectability (if possible), and those who remain with you are also to be borne on the said pay list, a form of which is herewith enclosed for your guidance, so that the whole of the expense incurred on your survey shall not exceed the number of men your party is rated at, which must be sworn to according to the form given.

“You must keep a field book of the whole of your operation, noting everything worthy of remark, but in particular the white and yellow pine, and the lots on which it is to be found, which must be so clear and distinct that the whole thereof may be traced on the plan, not only by a surveyor but by any person who can read writing, which must also be sworn to and returned with your pay lists and vouchers.

“You must keep a diary or journal, clearly explicit, as how you have expended your time, in which you must enter everything worthy of remark, particularly the white and yellow pine fit or not fit for masting according to the best of your knowledge and belief, and such mines and minerals, etc., that you may pass in the course of your operation, noting the lot and concession whereon the

same may be found, as directed in your field book, and you must be particularly careful in your diary or journal to enter the time and names of the persons whom you engage and discharge, according to their respective dates, so that the same may correspond with your pay list, which also must be sworn to and returned with your vouchers.

"Your pay list and vouchers for your pay, ration and abstract must be in quadruplicate.

"The rough plans of Yarmouth, Southwold and Houghton, herewith sent to assist you in your operation, on which are laid down imaginary lines upon which the courses of the road are supposed to run, the situation of which must be determined by measuring on the side lines of the several townships from lake Erie, until you intersect the road you are to lay out, when it is completed, which must be returned with the fair plans of your operation, on which must be laid down in a clear and distinct manner the mountains, hills, rivers, marshes, meadows and swamps, or whatever else may occur that may be remarkable for its singularity or utility.

"The principle on which Yonge street is laid out is, that the lots are 20 chains in front by 100 chains in depth; therefore it is requisite to observe that whatever obliquity you may have occasion to make from the concession lines of those townships hereafter to be run, making Yarmouth as the centre township the governing one for the three townships, then you will have to calculate the obliquity of the same on the angle or difference deviating from the concession lines of the township of Yarmouth, which Mr. Chewett will explain, and show you the method of calculating should you be unacquainted the nature thereof. The plans of Southwold, Yarmouth and Houghton, sent with these instructions, will point out how far this can be carried into execution.

"You must always have in remembrance that you cannot approach nearer to lake Erie with the rear boundary forming the concession on the road to be laid out than the rear boundary of the 7th concession in Yarmouth, nor the rear boundary line of the 4th concession in Southwold from the river Thames, which have been so far conceded.

"You must not, however, set out to commence your operation until such time as you have reason to believe that the waters have sufficiently left the woods, that there may be no plea of delay by being obliged to hire your party and to commence your operation at an unseasonable time of the year.

"A reasonable time when you arrive at Port Talbot will be given to you for the hire of your party and purchasing your provision, which it is supposed may be done at one and the same time, and also for going to and coming from your place of residence to Port Talbot, and for making up your plans and vouchers, and no more, and every exertion that a surveyor is capable of in carrying the same into execution with accuracy and dispatch is expected from you."

A party of surveyors usually consisted of ten men besides the chief, but as the woods in the west were supposed to be more open than elsewhere, Mr. Burwell concluded that he could effect the work with eight men, and so that number was placed in the instructions. He apprehended, however, that men could not be hired at the Government rate of wages, as they were accustomed to receive more from the farmers. Accordingly the Governor in approving the instructions agreed that "should it be impossible to procure men to assist the surveyor at the usual price, Col. Talbot must be requested to certify the lowest wages they are to be had for, which will be allowed upon this location." The regular rate continued without alteration for a long period. In 1797 it was the same as in 1809, but in 1815, after the close of the war, rates were increased, owing to the higher cost of living. "The notice you have taken of the prices of Labor and Provisions having risen within the last three or four years is very cogent," Mr. Burwell wrote to Mr. Ridout from Southwold, in November, 1815. "Provisions are dear here and Labor is high, which I expect is pretty generally the case throughout the Province. Farmers are giving from fifteen to eighteen dollars per month to laborers, which will make it difficult, if at all practicable in the present state of affairs, to execute the Surveys required at the former established rates. As to myself, I must confess that it is an arduous undertaking to be in the Wilderness exposed to the inclemencies of the Weather long at a time. It certainly impairs one's health. An increase of pay is desirable—but

it would be indecorous for me to state my humble opinion of what it ought to be. The circumstances which lead you to mention it, are sufficiently known to yourself as Surveyor General, and I shall be content with such additional pay as the Lieutenant Governor in Council shall deem expedient to establish." The scale was made 10s currency per day for surveyors, 3s 9d for chainmen and 2s 6d for axemen, with the usual allowance for rations. In 1818 a new scheme was introduced. Surveys of townships were let under contract, and payment was made in a percentage of the lands. The common allowance was $4\frac{1}{2}$ per cent., but if the land of a township was shown to be marshy or the quality of it poor, the percentage might be drawn from lands elsewhere.

Economy was enjoined upon all surveyors, and the records show that it was rigidly exacted. "You will pay the strictest attention to the economy of your time," Surveyor General Smith advised Abraham Iredell in 1803, "as the most minute scrutiny will be made in respect of the same." There was an audit of the accounts in Toronto, and afterwards an audit in London before they were finally passed, and for this reason all accounts and vouchers were required to be made out in quadruplicate.

It will easily be understood that on the allowances for wages and rations a surveyor could not be generous. In most cases he went into the woods without even a tent, and when it rained the men peeled bark from the trees and made a rude shelter of it. But as the bark will not always peel, it would happen that the party had to lie down without any covering, and in the journals of Mr. Burwell there are frequent notes of this kind of experience. There was no allowance of tea or coffee with the rations of flour, pork and peas, and the early records do not give a hint of any other beverage. But twenty years after Burwell's earliest venture as a land surveyor, when Roswell Mount of Caradoc was provisioning a party to lay out a township on the St. Clair river—it was named St. Clair, but has since been divided into the townships of Sarnia and Moore—he began with the purchase of a barrel of pork, a barrel of flour and a barrel of whiskey.

We have travelled far since those early days, as witness some articles in the allowance of stationery supplied to the surveyor of ninety years ago, for which he gave to the Surveyor-General a detailed receipt. One item is 25 quills, for although steel pens were made before the close of last century, they did not come into general use until the middle of the present one. Another was a stick of sealing wax to seal letters, long before the days of the envelope. A third was a piece of mouthglue, so completely gone out of use that a specimen of it would be a curiosity now. A fourth was "one Indian rubber," and a sample in my possession is as dry and hard and brown as a mummy of the days of old Rameses. There were also papers of ink-powder, black and red, but men under sixty may remember the use of ink powders. Some of us, whose faces have not lost the country bronze, who lived in the country school sections, twelve miles away from the nearest general store, may even recall memories of the fluid we helped to compound in an iron pot from the inner bark of the swamp maple, with green vitriol and sugar added—ink of just a slightly deeper shade of purple than Emperors were wont to use in writing their names, which shone like varnish on the paper and crackled like burning brush when the copy-book was opened, and was viscous enough to arrest a house-fly. I think that I could identify that swamp-maple ink upon the written page after a lapse of ninety years; yet, in spite of the scrutiny and microscopic economy of the audit office, I am sure that Mr. Burwell was never forced down to the level of using it, at all events not in his official correspondence nor in his journals. But the records afford not a few illustrations of the infinitesimal mind that directed the audit office when Francis Gore was Lieutenant Governor. One is reminded of Elia's man, John Tipp, of the South Sea House, who thought an accountant the greatest character in the world, and himself the greatest accountant in it. Auditor is Accountant writ large.

The surveyors often were annoyed by delays in the passing of their accounts, although it happened sometimes that the Receiver General was more to blame than the Auditor—when there was no money in the Treasury. This, however, is slightly a diversion, and I come back again to the subject.

Mr. Burwell was enjoined to read his instructions carefully, and not to leave Toronto until satisfied that he understood them; and he was directed without loss

of time, as soon as the season might permit, to proceed with the work, but not until he had reason to believe that the waters had left the woods, so that there might be no fear of delay by commencing at an unseasonable time of the year, with himself and his men idle while under pay. "I have perused my instructions and looked over the plans," he wrote on April 1st, "as carefully and as much as I possibly could for the short time I have had them in my possession, and see nothing to prevent my putting the instructions into execution as soon as time will allow." On the same day he drew the allowance of stationery, and having gone to his home in Bertie township he began to fit out for the enterprise in hand about the middle of May. Four days were spent in making out voucher forms, a field book and plans of the townships, and then he was ready to begin the journey to Port Talbot. I quote a few pages of the journal.

"Sunday 21st May. Could not set out with a Boat on account of the Ice being wafted to the North side of the Lake.

"Monday 22^d May. Believing it would be difficult to hire men enough at Long Point or Port Talbot for my Party to consist of, and being ready to set out I engaged three, by name, Edward Kerr, John and Robert Burwell. Kerr for a Chain Bearer at 2/6 currency per day, and the Burwells at 1/6 per day each. Set out from Fort Erie and reached Point Industry. It rained all Night."

Point Industry is west of Point Abino and Sugar Loaf. It is lot 14 on the lake shore, the most southerly land in Wainfleet, and was patented to David Morgan in 1817. It seems likely, however, that Morgan was an old squatter here, as in the first edition of D.W. Smith's Topographical Description of Upper Canada (1799), Industry Point is also called Morgan's Point.

"Tuesday 23^d May. We set out early in the morning, had contrary Winds, and it rained all day, however, by being assiduous we reached Oustine's Creek.

"Wednesday 24th May. Set out early. Winds still contrary, but reached St. Gust at 11 o'clock a.m., and the Wind breezed up so strongly from the South that we had to put into the mouth of the River for Safety."

St. Gust is one of the several aliases for the most southerly point of Walpole. In Smith it is called St. Dusk or Sangas, and the same name is given to the stream which empties into the lake just east of it: On the U. S. Lake Survey chart the stream is called Sandusky river, and the point itself Peacock Point.

"Thursday 25th May. Reached Colonel Ryerse's in Woodhouse, with some difficulty, by rowing against the West Wind. I embraced the afternoon to enquire for men to engage, but found none.

"Friday 26th May. The Boat I went up in went no farther than Long Point. I went to Dover in quest of one, and of men to assist me, but all to no effect.

"Saturday 27th May. Was told that Stephen Bartow of Charlotteville had a Boat. I went to get it, but he wanted it himself. Made enquiry elsewhere, but could not hear of any in the vicinity of Long Point, and I found no men to engage yet. Mr. Mitchell the schoolmaster informed me that Col. Talbot had taken considerable of pork to his place, and he presumed part of it was intended for me, also that I could get a sufficiency of Flour there, and finding that I could not get a Boat, I concluded to set out on Foot. I could not engage any Men.

"Sunday 28th May. Rained severely the whole day, that I could not start.

"Monday 29th May. Rained until 2 o'clock P.M. I offered two Indians the wages allowed, but they said it was too little. We travelled to the house of Thomas Welch, Esq., tarried all night.

"Tuesday 30th May. Set out early. Mr. Welch sent his son to pilot us to Big Creek, there being no Road to that place. Found the creek very high in consequence of the great fall of rain. Travelled on to within four Miles of Big Otter Creek and encamped. Rained smartly in the night.

"Wednesday 31st May. Hindered some time crossing Big Otter Creek, had to fall a large Hemlock Tree across it, which would have failed us, had not the Creek been narrower below, that the Banks interfered as it swam down. We had to fall a tree across Catfish Creek also and encamped on good land a mile to the Westward of the creek.

"Thursday 1st June. Travelled on to Kettle Creek and had to fall timber across it,—reached Port Talbot after Sunset and it rained in the Night."

At the mouth of Big Otter creek is now the village of Port Burwell, named

after surveyor Mahlon Burwell. At the mouth of the Catfish is Port Bruce. This stream was formerly called by its French name, Barbet river, and a line drawn due north from its mouth was the western boundary of Norfolk county. At the mouth of Kettle creek is Port Stanley, at first called Stirling. The name of this stream, like the one east of it, has also been anglicised, it having been known in the days of the French occupation as the Chaudiere river.

"Friday 2^d June. Colonel Talbot engaged William Coyl to go with me at 2/ per day it being the lowest he could be engaged for. Finding it impossible to get either Provisions, or men enough to constitute my Party at Port Talbot, I set out for Long Point in a Bark Canoe, that I might be at the return of the Boats from Fort Erie and engage one to take my Provisions to Port Talbot. The Weather somewhat unfavorable, that we only reached Catfish creek. After conversing with Colonel Talbot I found myself much at a loss how to act, his wishes differed so very much from the tenor of the Instructions I received from the Surveyor General's office."

This difference seems to have been owing to undue haste on Colonel Talbot's part, for the letters show that when he had perused the instructions he did not disapprove the plan.

"Saturday 3^d June. Left Catfish Creek early but were soon interrupted by a head Wind, however we proceeded on to the Three Gun Battery and encamped."

The Three Gun Battery is not now known as a geographical term on the shore of lake Erie, and I have not found it mentioned elsewhere than in Burwell's journal. It is again referred to in connection with a traverse of the front of Houghton. "Proceeded from Big Otter creek down to the Three Gun Battery," the Journal of July 4th notes; "here are immense Sand hills above the regular high Banks, from the summit of which is a prospect of all the surrounding country." Most likely it was a name given to the sand dunes in Houghton, ten miles west of Big creek in Walsingham, eight miles east of Big Otter creek in Bayham, and near to the hamlet of Houghton. There are three hills, which extend for three-quarters of a mile along the lake, and apparently have been built up with the sand blown by winds from the beach. The largest, which is on lot 10 and lies between the other two, is 990 feet long, 300 feet wide, and rises to 195 feet above the water's level. The lake bank itself rises to 70 feet, which is about the average height from Port Dover west as far as the county of Kent. Mr. John Alton of Houghton, to whom I am indebted for this description, has forwarded a sample of the sand, and states that the material of the hills and of the beach is as nearly as possible the same. It is composed almost wholly of grains of silica, with small percentages of felspar, limestone and garnet, all finely rounded. "You may wonder from its appearance," Mr. Alton remarks, "why it does not blow away. But it has the peculiar trait of holding moisture well, and during a season of drought one can kick out moist sand at a depth of one or two inches from the surface." The effect is to keep the hills solid and compact, and there has been little change in their form within the memory of the oldest settlers. They command the best view of lake Erie to be obtained at any point along the coast, and a number of tourists visit them every summer.

"Sunday 4th June. Proceeded on the way, crossed the carrying place, and arrived at Col. Ryerse's at night."

The carrying place from the lake to the head of Long Point bay at the end of last century was a flat of sand about eight chains wide, according to Smith, which sometimes was sufficiently overflowed to be used as a passage for small boats. As late as 1832 there was little or no change in its condition, according to Bouchette, there being a passage for boats through a small brook when the waters were high, and when they were low boats were easily hauled across the slender isthmus. Now Long Point is separated from the mainland by a wide channel of shallow water.

"Monday 5th June. Went in Quest of a Boat and men to assist me, was at the General Training of the Militia and engaged Cornwall Ellis and his Boat to take my Provisions to Port Talbot.

"Tuesday 6th June. I went to Townsend to hire men to go with me, but did not meet with any.

"Wednesday 7th June. I was fortunate enough to procure three Men, by name John Bacon, John Rice and Jesse Millard. I agreed with Bacon for 2.6 per Day with Rice for 2/, and with Millard for 1.4 per Day.

"Thursday 8th June. I engaged Jeremiah Wolfen to go with me for 1/8 per Day and was all in readiness to set out for Port Talbot, but the Wind blew contrarily that I could not proceed, and then Wolfen refused to go at all, and I could not complete my party, but determined to proceed in the morning.

"Friday 9th June. Loaded the Boat early and rowed against the Wind to the carrying place, or Isthmus of Long Point. We took everything across to be ready in the morning.

"Saturday 10th June. Loaded the Boat early and rowed against the Wind to Big Otter Creek; the Wind blew hard and we lay by. About 6 o'clock P.M. it calmed and we rowed up to Catfish Creek by 10 o'clock P.M. there was a heavy swell and when entering the mouth of the Creek the Boat had like to have filled and my Trunk and my Papers got wet, by which some drawing Paper was considerably injured.

"Sunday 11th June. There was such a violent sea that it was impossible to proceed on the way.

"Monday 12th June. The Lake raged most tremendously all day that we could not move out of the mouth of the Creek. So I searched for the limit between the Townships of Yarmouth and Houghton, on both sides of the creek, but all to no effect.

"Tuesday 13th June. Early in the morning I set out with a pretty rough Lake and we rowed hard until 2 o'clock P.M., when we reached Port Talbot.

"Wednesday 14th June. It rained very hard all day that I could not proceed into the Woods. Colonel Talbot altered his opinion respecting the operation and did not wish to deviate from the intent of my instructions and I regretted that I had written the Acting Surveyor-General on the subject."

These extracts from the journals show the difficulties and dangers which beset the early surveyors of our Province in parts of it which were the most easy of access by the best transportation of the time. To reach Port Talbot from Fort Erie with assistants and provisions, Mr. Burwell was occupied twenty-four days, and during much of that period himself and the men were exposed to the stress of weather, without shelter, and sometimes in peril of their lives; and journeying slowly on as best they could, on foot through a wilderness of brushwood and briars, or in open boat coasting a shore of high bluffs on the most treacherous of all the great lakes, which in the months of May and June is peculiarly liable to gales that sweep it for an unbroken length of more than a hundred miles from the south and west. Today a party can leave Toronto in the morning, take a run of 120 miles in a railway coach, drive fifteen miles across country along a finely graded road, and arrive at Port Talbot early in the afternoon of the same day. That fifteen miles embraces the first section of the Talbot road which Mr. Burwell was employed to survey. Some of the best farming land in Canada is to be seen there; and if on reaching the Southwold and Dunwich townline the traveller enquires, he may have pointed out to him the house where Col. Mahlon Burwell lived with his family for a third of a century, as well as the little building of red brick where he kept the register of titles for Middlesex county; and beyond these the quiet churchyard by the roadside where, under the shadow of great forest trees, is a grass-covered mound and a stone with this inscription:

SACRED
TO THE MEMORY
OF
MAHLON BURWELL
WHO DEPARTED THIS LIFE
THE 25TH DAY OF
JANUARY A. D. 1846
AGED 62 YEARS
11 MONTHS AND 7 DAYS.

HE WAS FOR SEVERAL PARLIAMENTS A MEMBER OF THE HOUSE OF ASSEMBLY FOR THE COUNTY OF MIDDLESEX, AND FOR ONE PARLIAMENT MEMBER FOR THE TOWN OF LONDON.

In the plan of this paper I have purposely entered into details of the beginnings of Col. Burwell's work as a land surveyor, to illustrate the value of his letters and journals as materials of history, but without a pretence to elaborate them into literary form—for history is not written hastily in broken hours at the end of a day's work. What remains to be done is the harder task of presenting within the limits of a few pages a clear idea of the extent and nature of Burwell's labors during the next twenty or more years of active career as a surveyor; or down to the time when, though still in middle life, his physical powers had decayed and he was no longer able to execute a commission from his chief. "Should His Majesty's Government require that this township (Dunwich) should be re-surveyed," he wrote to Acting Surveyor-General William Chewett on February 24th, 1832, "may I beg that you will not order me to perform the service, as my health would really not permit me to go into the woods at this time,"—and he suggested the name of another to whom the order might go instead. After that time it does not appear that Mr. Burwell attempted any work for the Government except to finish the surveys of one or two townships which he had commenced long before. A list of his undertakings from 1809 to 1835 includes surveys in whole or in part of the townships of Wainfleet, in Haldimand; Houghton, Middleton and Townsend in Norfolk; Bayham, Malahide, Southwold and North Yarmouth, in Elgin; Caradoc, Ekfrid, Lobo, London, Mosa and Westminster in Middlesex; Harwich, Howard, Orford, Raleigh, Romney, Tilbury East and Zone, in Kent; and Colchester, Gosfield, Maidstone, Mersea, Rochester, Sandwich and Tilbury West, in Essex. The list also includes surveys of the towns of London and Chatham (the latter being a re-survey); of Talbot Road East, from the west line of Southwold to the east line of Middleton; of Talbot Road North, from the west line of Southwold to the junction with the Longwoods Road in Westminster; of Talbot Road West, from Port Talbot to the town of Sandwich on the Detroit river; of the Middle Road, midway between lake Erie on the south and the river Thames and lake St. Clair on the north, from the east line of the township of Orford to a point of junction with the Talbot Road in the township of Sandwich; of the Brock Road in Wellington, from Guelph to the rear of Flamboro; of the north limit of lands purchased from the Chippewa Indians in 1827, from the northwest corner of Garafraxa to lake Huron; besides several Indian reserves in the counties of Middlesex and Lambton.

The survey of Talbot Road East, or Colonel Talbot's Road, as it was first called, occupied the whole of the season of 1809 and part of 1810; and the work was pushed on without cessation every day the party was in the woods, the only days of rest being the rainy days. The limits between Dunwich and Southwold, Southwold and Yarmouth, Yarmouth and Houghton, and Houghton and Walsingham were first traversed, the western boundary of Yarmouth being intended as a governing line, and the most eligible points of intersection for the road were found in this way. No difficulty was experienced in discovering a suitable location across Southwold and Yarmouth, and only two courses were necessary in the former, made to avoid a marsh in which Talbot creek had its source. The southern part of Yarmouth had been surveyed in 1799, where a grant of 5000 acres was made to Hon. James Baby and his brothers. In the instructions to Surveyor Jones Yarmouth was described as situated between Southwold and Houghton. The original intention was to run the road through the seventh concession, but Mr. Burwell's explorations showed that a more favorable route was one on the line between the eighth and ninth concessions. He reported it as "an extraordinary place for the Street to pass, there is but Four Chains of Swamp the whole way and that not bad." To the east of Yarmouth the country along the projected line was broken by gullies and swamps. "All the creeks of any account between Port Talbot and Long Point," Mr. Burwell observed in one of his letters, "come from the North East to within about eight miles of the Lake, and then run nearly a South course into it." This was the real cause of the difficulty of finding an easy route across Houghton—whose western boundary at that time was the east line of Yarmouth—for the direction of the road was nearly parallel to the main streams in their upper reaches, and it crossed many of their tributaries. But a fairly good route was obtained in the end, which for the last thirty miles eastward lay in a splendid forest of pines. The terminus of the road was at the eastern line of Middleton, where the village of Delhi now stands; but the name of Talbot Road has been applied to one extending eastward through Cayuga in Haldimand.

Mention has been made of the difficulty Mr. Burwell had in procuring supplies of provisions for his first campaign. He was destined to have more experience of the same sort before the end of the season. The quantity which he at first thought sufficient to complete the survey was entirely expended at the beginning of September. Everything was in such a situation that the whole party had to march out, as clothes and shoes were required as well as provisions. The first day they travelled twenty miles and encamped on Big creek. Going by way of Townsend, the settlement on the lake was reached on the third day. But all the flour there had been sent away, and the only thing to be done was to thresh wheat and get it ground. A team was hired to carry a barrel of pork from Col. Ryerse's to Townsend, and on the fifth day the men threshed seven bushels of wheat and took it to Sovereign's mills. But the miller was not at home, and as a last resort on the seventh day the grist was ground by one of Burwell's own men.

On Sunday, September 10th, Mr. Burwell records in his journal, "I took a Boy and Two Horses whom I had engaged to Pack the Flour and Pork to the Survey on the Old Road, had much trouble on account of Logs, Brush, Briers, &c., but Reached Big Creek." Next day the provisions were packed into Houghton, "and it took us faithfully all day to proceed Seventeen Miles." There a deposit was made, and taking a supply they proceeded to resume work at the point they had left twelve days before. Such is an instance from life in Norfolk county ninety years ago.

In 1810, besides finishing the survey of Talbot Road East, Mr. Burwell surveyed the southern part of the township of London, which was believed to be suitable for the cultivation of flax. "I kept a Proof Line in the centre of the Township," he wrote to the Surveyor General's office, "that my Survey might be as correct as possible, on which I Proved every Concession Line that I run, by measuring on the said Proof line, and can say that the operation is very correct." This was the origin of the name of the road which leads out of the city of London to the north boundary of the township. He also received instructions to survey the vacant land between Houghton and Yarmouth, and to divide it, if sufficiently extensive, into two townships, under the names of Malahide and Bayham. The work was done accordingly, and under date of February 12th, 1811, the Lieutenant Governor commanded his secretary to acquaint the Surveyor General that "the townships of Malahide and Bayham are to be annexed to the county of Middlesex." In making this survey Mr. Burwell selected a block of land in Bayham at the mouth of Big Otter creek, a part of which was subsequently surveyed for a town plot and called Port Burwell. Writing of that region to the Surveyor General in June, 1815, he said: "Otter creek discharges more Water than all the small Rivers which disembogue themselves into the North side of lake Erie excepting the Grand River. When a few drifts are cleared out of it, Boats may descend from the Mills in Norwich to its mouth, at almost any Season of the year. There are beautiful Groves of White Pine Timber, on each side of the Creek, interspersed with Groves of other Timber, alternately; there is therefore no doubt, but what ere long considerable quantities of Lumber will be conveyed down that stream, from Norwich and other places to the Lake. It would appear as if Nature had intended the mouth of Big Otter Creek for a place of greater importance than any other in the District of London. In my mind it is highly probable that such will be the case before many years. I am about to lay out what Land I own on the East side of the mouth in a Town Plot." At the same time he encouraged the Government to lay out an adjacent lot held as a reserve for the same object; and "if it should meet with the approbation of His Excellency the Provisional Lieutenant Governor, it would much facilitate the future growth of that part of the Province, to have it laid out by the Government, for a Town at the mouth of Big Otter Creek." But these bright anticipations have not been realized, and although the town is beautiful for situation, it has been for many years a finished town. Like its neighbor town, Vienna, on the same stream, its glory departed when the last of the Big Otter pine was cut.

The north branch of Talbot Road was laid out in 1811, the object of it being to connect the main line of the Talbot Settlement with the road through Westminster. Its western end is at the Dunwich and Southwold line, where the village of Iona now is, and it extends eastward through Southwold parallel with the main

road, to a point where five roads converge, long known as Five Stakes, but now called Talbotville Royal. Thence the road runs north to join the Talbot Longwoods Road in Westminster at a place formerly known as the Junction, but now called Lambeth, six miles from the city of London.

An instruction was received the same year to survey under the direction of Col. Talbot a road from Port Talbot west near the shore of lake Erie to Amherstburg on the Detroit river, to be known as Talbot Road West. "In surveying the Road through Dunwich and Aldborough," Mr. Burwell wrote to the Surveyor General on October 24th, "Colonel Talbot directed that I should begin to number the Lots from his Mills and continue to the westward, which I have done, and also continued numbering them in succession as far as the Survey extends at present; without regard to the Townships through which they pass." Work was commenced on August 26th and was carried on until September 8th, when the survey reached lot 90, near the west side of Howard, and was then discontinued for the season.

It is likely that Mr. Burwell had before this time left his home in Bertie, as a deed dated February 25th, 1812, from Col. Talbot to him of a small piece of land in lot 24 of the 11th concession of Dunwich, describes him as of Port Talbot.* But the war between the United States and Great Britain, which had been threatening for several years, broke out in the summer of 1812, and until peace was again established surveying operations near the frontiers of this Province were suspended.

Only a few references to the war occur in Mr. Burwell's official letters, and no information is conveyed in them that he was engaged in military service. The report of the Loyal and Patriotic Society states, however, that he was active against the enemy on all occasions and became odious to them. The letters show that he was at the Niagara frontier in 1812 and 1813, when fighting was going on there, and that in the following year, when a small body of American soldiers ravaged the Port Talbot settlement, he was carried off as a prisoner of war and his maps and instruments destroyed. A map of Malden had been given by him to Proctor when that General was on his way to take command at Amherstburg in 1812, which was afterwards taken by the enemy and destroyed, with his papers. "The Plans of the other Townships I had deposited, with the Instruments and other appendages of my Surveying Establishment, at a person's House, where I thought they would not be likely to be suspected or discovered, but when the plundering party came through which swept the whole Settlement and captured me, all was taken and destroyed—and I have not been able to get properly equipped with Instruments yet." This was in explanation to the Surveyor General (November 4th, 1815) of the loss of plans of townships traversed by the projected Talbot Road West. One other reference to the war is worth quoting. It is found in Mr. Burwell's journal of the Talbot Road West survey under date of September 18th, 1816. "I passed the place in Front of Lot No. 177 (Tilbury East) where Major Holmes of the United States Army, had encamped a Day or two, when on their intended expedition against Port Talbot in time of the late War. I find here, as well as upon every other occasion, when they have remained all night in our Woods, they have felled large Trees flat to the Ground all round their Encampment, to serve as a Breast Work in the event of an attack. Two Field Pieces and ammunition Waggon were left here by Major Holmes, which were destroyed by the Loyal Essex Rangers. The Carriages were burnt, and the Guns and ammunition were carried back and deposited in a Black Ash Swamp where they remained until the Treaty of Peace." The Major Holmes of this record is no doubt the same officer as the Colonel Holmes commanding at Amherstburg, mentioned in Sir Gordon Drummond's dispatch of May 27th, 1814.

The survey of Talbot Road West was resumed by Mr. Burwell in the summer of 1816, and under instructions the western terminus was fixed at Sandwich instead of Amherstburg. The final report upon it was not sent in until the end of 1824.

The first settlements in Kent county were formed upon the river Thames, and after the Talbot Road began to be opened up a scheme was proposed to the Government by Col. Talbot for a main road to follow as nearly as practicable the height of land between lake Erie and river Thames across the county. This was referred

* Mr. Gill, the registrar of London, informs me that Mr. Burwell was appointed registrar of Middlesex in 1811, and that the first deed was registered by him May 28th of that year. The first registry office for the London and Western Districts was established February 20th, 1801, and the seat of the office was at Turkey Point, with Thomas Homer as registrar. The office was afterwards removed to Vittoria, and again to Princeton.

to Mr. Burwell, and reporting thereon to the Surveyor General in August, 1821, he expressed the opinion that the laying out of a Middle Road on the highest ground or dividing ridge would tend much to quicken and consolidate the settlements between those waters. The work was entrusted to himself, but as the road as finally laid out extended from a point of junction with the Talbot Road in the township of Sandwich eastward to the county line between Kent and the present county of Elgin, it was not completed until September, 1825. The last division of the survey is the most easterly, being in the township of Orford, and as the height of land there is very irregular it was found necessary to alter the direction of the road frequently. There are in all twenty-eight courses across the township, which has a width of $6\frac{1}{4}$ miles, and only one lot has a straight front. A large tamarac swamp was met with on the way, and there is a tradition that Mr. Burwell was nearly defeated in the effort to find a pass through it. The situation was reported to Col. Talbot, who with his usual urbanity directed the surveyor to follow the ridge. "Follow the ridge, if it takes you to—Hades." But I need not say that Col. Talbot used another word.*

There are many matters of interest connected with surveys of the townships north of the Thames, and of Indian reserves there and on the St. Clair river and lake Huron in Lambton county; and there are also some interesting observations of natural history that deserve attention. But these must be left unnoticed in this paper, in order that its short remaining space may be devoted to the largest of Mr. Burwell's undertakings in his later years as a land surveyor.

The Government of the Province in 1825 made provisional terms with the Chippewa Indians of the London and Western Districts for the surrender of 2,200,000 acres lying to the north and west of former cessions, and about the same time it entered into an agreement with the Canada Company for a transfer of 1,000,000 acres of the same land, in a block which afterwards became famous as the Huron Tract. By order from the Surveyor General's office of July 6th, 1827, the survey of the northern boundary of the new purchase was undertaken by Mr. Burwell, and the work was carried on and completed during the months of September, October and November. Provisions for the expedition were purchased at Guelph, and were packed northward to the starting point of the line, at the northwest corner of Garafraxa. A journal entry of September 19th reads: "Met Mr. Galt near Guelph, who invited me to dine on Friday the 21st Instant at his House near Burlington Bay;" and under the latter date is this entry: "Went to Dine with Mr. Galt at his House—was civilly treated—an agricultural party—Mr. Galt proposed that I should be a member of the Agricultural Society of which he is the head. I declined. Did not know that it was an agricultural meeting until after the cloth was removed. Left Mr. Galt's about 10 o'clock P.M. and slept at Mr. Beasley's." This is the nearest approach to a supercilious tone that I have discovered in all of Mr. Burwell's official writings. But no one could have more heartily enjoyed the scorn of the land surveyor than John Galt himself.

The survey of the line was commenced on October 4th. Ten days were spent in running $18\frac{1}{4}$ miles, as progress was much hindered by dense swamps of cedar, tamarac and spruce. Then the head waters of the Menesetung river (now called the Maitland) were reached, and a very fine country was entered. During the next ten days the line was run $29\frac{1}{2}$ miles, and the river was crossed frequently. In four days more, during which the survey bore away northward from the river, lake Huron was reached at 59 miles 39 chains from the starting point. Storms of rain, hail and snow were frequent, and the actual running time was only nineteen days.

The return journey occupied six days, and was made disagreeable by storms of rain and snow, and by the swollen waters of the river, which had to be frequently forded. The stores of provisions which had been left at various points for the return trip were found to be destroyed by wild animals, and it was observed that bears, wolves, foxes, fishers and martens had followed the party along the line. A note of Natural History is entered in the journal of November 3rd, upon the authority of the Indians. "The Deer all appear to have left Lake Huron, some time ago, for the Shores of Lake Erie, where the Snow does not fall so deep, and

* I heard this story from the late John Sinclair, who moved from Aldborough into Orford in 1832, and took up a lot on the Middle Road. My father, the late John Blue, was the second settler on this road in Orford, having been located by Col. Talbot late in 1826 or early in 1827. His nearest neighbor was four miles away, and the woods were alive with turkeys, deer and wolves.

this the Chippewa Indians inform me is uniformly the case with them every Autumn, to avoid being taken by the Wolves during the deep snow of this neighborhood, which is frequently crusted over." This is doubtful, and I do not think it has been confirmed by observation elsewhere in our country.

The instances are exceedingly rare in which the land surveyor unbends himself in the letters and journals of Mr. Burwell, and one might suppose that the beauties of landscape and of woodland scenery were unappreciated by him. But over the Huron Tract he grew almost eloquent. "Notwithstanding the fatigues and privations attendant on such a tour," he reports to the Surveyor General, "I have had great pleasure in Surveying the purchase line—the country through which it passes is magnificently fine. The River Menesetunk is about half the size of the Thames. It is a fine River of pure clear water. Its banks afford numerous eligible situations for country seats to the right and left, sufficiently elevated and in variety to add beauty to their appearance, and in general they are easy of access, and the Flats extensive. When you are in possession of the Field Notes, Map, and report of the Survey of the purchase line, and the exploring expedition for the Canada Company in detail you cannot fail to feel a deep interest in this part of the country."* It would be a wonder indeed if a stream of so much picturesque beauty flowed on forever without a poet to write a verse in praise of it. The Menesetung has its singing lover, and although I think his genius has been nurtured overmuch on the metrical version of the Psalms of David, he sings out of the heart with a swelling note and a touch of Robert Burns.†

Unknown to fame thy waters run,
Past groves of living green ;
And all obscure they gently flow
Thy leafy banks between ;
Thy beauties ne'er have found a voice,
Thy charms are yet unsung ;
Be mine to sing in humble strains
Thy praise, Menesetung.

No tumbling torrent roaring down
Its rocky bed art thou ;
Thy peaceful waters murmuring low
Kiss soft each nodding bough ;
The sombre cedars bathe their limbs
Thy crystal depths among ;
And mirror'd hemlocks sigh to thee,
Oh, fair Menesetung !

The dappled trout in many a pool
Their speckled beauties hide,
Or, startled from their shy retreat,
Swift down thy current glide ;

* Menesetunk, as the word was written by Burwell, is stated by him to signify in the Chippewa language a large, open harbor. In a private letter to Ridout he says : " The Canada Company have called it the Nocton, after an estate of the Father of Lady Goderich in England, and they have called the mouth of the River Goderich Harbor." Mr. J. C. Bailey, the railway engineer, who is one of the best of our local authorities, writes in reply to an enquiry : "Goderich, or in that neighborhood, was called by the Indians Ma-ne-se-tung. So, if the Maitland river was called after the village—as the rivers generally are—it should have the word 'se-be' after it, which means a river, and should then read Ma-ne-se-tung-se-be. Me-nis means an island; Me-nising, in, at or on an island; Me-ne-ting, an island in a river; Me-ne-te-goje-wun, an island in a rapid." At about 25 miles from the starting point of the purchase line survey it is described by Burwell as "a fine River with Islands, gentle banks, and Stoney bottom."

† The writer is my associate in the Bureau of Mines, Mr. Thomas W. Gibson, who was born in the village of Wroxeter, on the banks of the Maitland.

The wild canary builds her nest,
And rears her timid young
Upon thy calm sequestered banks,
Oh, sweet Menesetung !

No lordly ships thy bosom bears,
Slow-moving, one by one,
Unknown, obscure, thou turnest still
Thy bright face to the sun ;
But while my heart within me beats
Till life's last change is rung,
I'll love thee still, and love thee well,
Oh, dear Menesetung !

But if an idea that once possessed some leading men of the Canada Company had taken substantial shape, the "lordly ships" might have become a moving feature on the bosom of the Menesetung. Mr. Burwell was strongly impressed with the practicableness of the scheme ; and in his report to the Surveyor General he ventured the opinion that the river might be the means of affording greater facilities for making a canal to pass between its banks and communicate between lake Huron and lake Ontario than any other that could be selected for the purpose. This river, he observed, passed through a very fertile tract of country, and discharged itself at a good position into lake Huron, so that a canal in its direction could not fail to produce very great advantages as well in a commercial as in a military point of view. "In producing the purchase line from its place of beginning, after crossing several rills trending in Northwesterly directions, I crossed the Menesetung in the 21st Mile at which place it is 80 links wide, and 18 inches deep, coming from the North East and affording I should think a sufficiency of Water for a canal. Between the 21st mile and the 45th mile, the line crosses the Menesetung, which constantly increases in size, seventeen times alternately, when it leaves the line and trends southerly to where it disembogues itself into lake Huron. Its general course is westerly, watering equally well the tract of country not yet conceded to His Majesty's Government with the late purchase. The rapidity of its current will compare with that of the River Thames, or Grand River, excepting that for several miles above the outlets of those rivers, their waters are apparently dead while the current of the Menesetung continues to within half a mile of its entrance into Lake Huron. The Grand River having its source nearly upon the summit level of the lands between Lake Ontario and Lake Huron, and being sufficiently large to afford feeders to a canal to both right and left, I conceive that the difficulty of connecting its waters with those of the Menesetung and the 12 Mile creek might be accomplished with more ease, and at less expense of excavation than might be at present anticipated. I should think that a position some ten, or fifteen miles above the Falls of the Grand River might be the best ; from whence a connection could be made with the waters of the 12 Mile creek, along the side of which the canal could be taken to Lake Ontario. Should such a work be undertaken, and a position selected for crossing the Grand River at, or near the Falls, the feeder could be brought from a sufficient distance up the Grand River to avoid any increase in the expense of excavation save that of the feeder, and then if it was thought expedient, the Canal might be taken past the Town of Guelph, and connected with head waters of the 12 Mile creek in Flamboro' East, not far from the Road which has lately been surveyed from Guelph to the rear of the Flamboro's, or if no obstacle should prevent it, pass directly to the Canal at Burlington Bay." But nothing was attempted, and however feasible the project might have been when the whole country was in forest, and the streams were full and strong-flowing throughout the year, it is scarcely possible under present conditions that it can ever be revived.

There are a number of other interesting matters in the Burwell letters and journals that I would gladly have touched upon, but my paper is already much

too long. In the preparation of it one of my aims has been to direct the attention of others who have more leisure than myself, and who possess historical tastes and gifts, to a treasure house of material which no one has yet ventured to explore or work over, and of which the Burwell letters and journals are a very little part. But whoever will undertake to exploit that treasure house with any degree of intelligence and thoroughness will soon become convinced that there is necessity for a new departure in the care of its contents, which ought to be treated as possessing great historical as well as official value. If we cannot have a Reference Library for the Province, with a Librarian possessing industry and genius in charge of it, established upon the scheme conceived and matured by the Canadian Institute, let us at least have a Provincial Archivist, whose office should be the collection and care of every paper, and letter, and record, and document that concerns the public and official business of the Province.

BIOGRAPHICAL NOTE. The Burwells are an old family, whose homes in England were in Bedford and Northampton. More than two and a half centuries ago some of them came to America, settling in Virginia. They were loyal to Charles I. throughout the Civil War, and some were loyal to George III. in the American War of Independence. In Sabine's *Loyalists* a sketch of one James Burwell of New Jersey shows that he served the King seven years, having enlisted in 1776, that he came to Upper Canada in 1796 where he received 200 acres for himself and each of his children, that he removed to the Talbot Settlement in 1810 and died there in 1853, aged 99 years five months. He was probably related to Adam Burwell, but that is uncertain. The latter was also a native of New Jersey, and came to Canada with his wife and family after the war. The records show that he settled in the township of Bertie, and that in 1797 he received a grant of 850 acres of land for military service; but the petition in which his claims were set out appears to be lost. There is a tradition in the family that he had large possessions in New Jersey, and that they were confiscated by the Government of the United States. Adam Burwell spent the later years of his life with his son, Col. Burwell. He died in 1828 at the age of 79, and was buried beside the walls of the English church in St. Thomas. His eldest son was the Mahlon Burwell of the foregoing paper, who was born in New Jersey February 18th, 1783, studied land surveying, and through the influence of Col. Talbot got professional employment from the Government. In 1811 Mahlon Burwell was appointed Registrar of land titles for the District of Middlesex, and in 1812 he was elected to represent the Districts of Middlesex and Oxford in the Legislative Assembly of Upper Canada. He held the rank of Lieutenant Colonel of militia at this time, and during the war of 1812-14 was active against the enemy on all occasions, and became odious to them, although there is no record of his being in any battle of the war. In 1814 a band of Americans raided the Talbot Settlement, and although Col. Burwell was in his bed, ill of fever and ague, he was carried off a prisoner and held for many weeks in Ohio or Kentucky. In a second raid his buildings were destroyed by fire and his family was driven off. In 1815 he was established in Southwold, where the Talbot Road crosses the townline between Dunwich and Southwold, afterwards known as Burwell Park. A new Registry building was erected there in which the office was kept until by authority of an Act of the Legislature it was removed to London in May, 1843. Col. Burwell was re-elected to represent Middlesex and Oxford in 1816 and again in 1820. A redistribution took place before the next general election in 1824, and John Matthews and Dr. John Rolph were chosen to represent Middlesex. They were successful again in 1828, and referring to this contest in a private letter to Hon. Thomas Ridout (Aug. 22nd, 1828) Col. Burwell wrote: "Our Election lasted 6 days—when the Poll closed the votes stood—for Rolph 340—Matthews 317—Burwell 305 & Hamilton 275, Matthews 12 over me, and many of my Friends not allowed time to vote, although returned to the poll two or three times for that purpose." In 1830 Burwell was successful in Middlesex, but was defeated in 1834, and in 1836 he became the first representative of London town. During the whole of this period he held the offices of Registrar and Postmaster, and was almost constantly

employed by the Government as a surveyor of Crown lands. But in those days the provisions of the Act for the Independence of Parliament were not as rigid as they are now. Col. Burwell had a family of seven sons, all but two of whom were named after great soldiers, viz., Alexander, Hercules, Isaac Brock, Leonidas, John Walpole, Hannibal and Edward. He had also two daughters, Louise and Mary. Of these only Edward and Mary are now living. All except Alexander and Louise are named in the will, which was executed eight days before Col. Burwell's death, and Alexander is no doubt the child referred to in a pathetic note to the Surveyor General (Dec. 20th, 1817) written to explain delay in reporting a survey in Westminster. "You would have received the report long since, had it not been for a most dreadful circumstance which occurred in my Family in October last, which deprived me of the use of my right hand for more than two months—A little son of mine two and a half years old was scalded to death, and in taking him out of the boiling water I scalded my Hands as related, but my right hand the worst." One ambition of Col. Burwell's life was to found a family, and with this object he memorialized the Governor in Council in 1829 for permission to extinguish his claim for 10,000 acres of land held in small isolated areas and receive in lieu thereof a block of 10,000 acres on lake Huron, adjoining the southern boundary of the Canada Company's territory, wherewith to make an entailed estate to his heirs forever. But no action appears to have been taken in the matter, and the records do not even show that the memorial was considered. But the idea possessed Col. Burwell's mind to the end, and by the terms of his will it was provided in the case of each of the sons that the lands bequeathed should be held to himself and his male heirs forever, and in the event of anyone of the sons dying without issue the lands should descend to the next son and his male heirs. "I have willed thus to fasten the before mentioned freehold estates upon my children and their heirs forever because my own experience, which has been extensive in this Province, and History have shewn me that children place less value on that which is given them than that which they acquire by their own care and industry; and because I have acquired the estates so willed and devised by a steady perseverance and laborious industry in my profession as a surveyor of lands, of which my heirs can never be sensible: I exercise this moral, legal and conservative right for their benefit: And when advanced in age my heirs in all time to come if they be sensible persons will know how to appreciate the soundness of my motives." Ermatinger, who has written unjustly and unkindly of Col. Burwell (Life of Col. Talbot), says he was tall in stature and dignified in appearance.

THE ILLECILLEWAET GLACIER IN THE SELKIRKS. BY ALBERT PENCK.

From The Journal of The German and Austrian Alpine Society.

(Translated by D. R. Keys, Toronto, Canada.)

(Read April 29th, 1899.)

The Cordilleras of Canada separate a well-watered coast from an arid interior. The moist winds, which blow from the northern Pacific into the interior, on meeting with the individual chains of the mighty mountain system, give up their moisture and then pass on, dried out like the Swiss Fohn, over the valleys beyond, until they have to ascend anew in order once more to lose their aqueous vapor. Each of the different chains, which, running north and south, form the Canadian Cordilleras, has, like the Cordilleras themselves, its weather side and its dry side. This is seen plainly in the course of the snow line. It lies lower on the west slope of the chain than on the east side. He who would view the Cordilleras as a snow-clad chain must observe them from the west; from the east they appear as a rocky chain, the "Rocky Mountains."

It is a bare, bald wall which rises above the great plain of North America. When first seen in lat. 51° N., not far from Calgary on the Canadian Pacific Railway, it resembles the Karwendel chain south of Munich, and although here reaching a height of nearly 3,000 meters, it is below the snow-line. It is the same in the National Park near Banff, so rich in beautiful landscapes. Not till we approach the watershed between the Atlantic and the Pacific streams, do we see snow-fields and glaciers. Near the height of land we can see from the railway the glittering ice upon the flanks of Mount Stephen. It is barely 200 meters higher than the highest mountains around Banff, and if capable, like its neighbors, of supplying ice streams, this is due less to its height than to its western position. Its situation brings it further into the snow limit which here must be sought considerably below 3,000 meters, (somewhere between 2,700 and 2,800 meters high).

The chief range of the Canadian Cordilleras, the Selkirk chain, lying in the bend of the Columbia river, likewise appears free from snow when seen from the east. These are broad-shouldered mountain masses, which rise to the west of the broad valley of the upper Columbia near Donald. The scenery here reminds one of the wide valley of the Inn with the Patscherkofel above Innsbruck, and the railway line which leads up along the Beaver Creek encloses landscapes like those of the Brenner railway. The top of the Roger pass (1314 m.) is, however, a narrower cut in the mountain than the Brenner; on both sides rocky peaks tower up to 2,800 or 2,900 meters. Then it descends into the valley of the Illecillewaet, the railway making the descent by a series of loops. At the same time a magnificent glacial landscape is unfolded and soon the train stops in sight of the splendid Illecillewaet glacier at the station called Glacier, (1256 m.) This station was the headquarters of William Spotswood Green* and Topham, Emil Hueber,† and Carl Sulzer,‡ as well as H. P. Nichols§ and Charles E. Fay|| in their ascents of the mountains and glaciers of the Selkirks. The passenger trains of the C.P.R. make this their mid-day station. Those on board here enjoy a

*Explorations in the Glacier Regions of the Selkirk range, British Columbia. Proc. of the Royal Geographical Soc., London, 1889, p. 153. Among the Selkirk Glaciers, London, 1890. (This book I had not at my disposal). Climbing in the Selkirks and the adjacent Rocky Mountains, the Alpine Journal XVII., 1895, p. 289.

†Im Hochgebirg von British Columbia, Jahrb. Schweizer Alpen-Club, XXVI., 1890-91, p. 258.

‡Bergfahrten im Far West. Ibid., p. 290.

§Back Ranges of the Selkirks. Appalachia VII., 1893, p. 101.

||Up to the Crags of Sir Donald. Ibid., p. 157.

spectacle such as can be seen on no other artery of the world's travel. Scarcely 2½ kilometers from the station above the dark pine of the primeval forest shines a glacier in the perfection of purity. On the left Sir Donald (3250 m.) raises its proud summit of rock, from which a comb extends in whose cirques twinkle snow fields and tiny glaciers; the Eagle and Avalanche peaks stand out boldly. On turning around you see the beautifully formed pyramid of Mount Cheops, which although only 2,704 meters high conceals a couple of glaciers on its flanks. If the loop of the Brenner railway at Gossensaß extended as far as Innerpferssch and the Feuerstein glacier came to meet it at Stein, then one would have a European parallel to the magnificent surroundings of Glacier House, which the C.P.R. has erected here, with every comfort in the immediate vicinity of its line.

I could not indeed quite fully enjoy this scenery when I reached Glacier Sept. 3rd, 1897. I came as a member of one of those exceedingly instructive excursions under excellent guidance, (our guide was the Director of the Geological Survey of Canada, Dr. Geo. M. Dawson), which were connected with the meeting of the B.A.A.S. in Toronto. Heavy clouds were collecting over the mountains and from time to time showers fell. The plan of some enterprising members of our party, to climb Mount Abbott (2,380 m.) behind the hotel immediately after the train arrived, proved impracticable and all our attention was concentrated on the Illecillewaet glacier, which was introduced to the travellers as "The Great Glacier of the Selkirks." The position of its tongue makes it certain that the snow line here lies very deep. In view of the small glacier on Mount Cheops and of small ones figured by Green on Mount Abbott, I should estimate it at from 2,200 to 2,300 meters at the highest, which, considering the dryness of the territory lying further west, appears remarkably low.

The way to the glacier leads through the primeval forest with its lofty trunks, under cedars, Douglas firs, Canadian pines, hemlock trees and balsams, which conceal it from view, until we leave the wood. There to the south of the road lies a great boulder which affords an excellent view of the ice tongue, (Point P5 of the diagram). It reminds one to some extent of the Rhone glacier; rising with a gentle slope it is traversed by only a few radial fissures. Above there is a precipitous ice cascade. Here the glacier is broken up into individual *seracs*. The higher glacial field, the névé does not become visible. It leads across to the Geikie glacier. A moraine, 70 to 150 m. broad, extends around the tongue and continues up the sides in two lateral moraines. The one on the right, near the foot of the wall over which the glacier descends, rises some 30 meters above it, the one on the left is considerably higher and steeper. This ground, which it is plain has only lately been free from ice, is surrounded by a space twice as broad, on which there is nothing but low underbrush. Then follows the forest with its giant trees in which lies our point of observation.

There can be no doubt that the glacier is retreating fast. The flat form of the tongue shows this, and still more the moraine in front of it. It can only recently have been free of ice, otherwise it would certainly have been occupied by the luxuriantly growing plants of the land. As a matter of fact one of Notman & Son's magnificent photographs taken in 1888 does not show the moraine. At that time the ice reached close up to the underbrush, and was surrounded by a low wall of boulders which now encircles the space free of ice with a terminal moraine perfectly well defined although only a few meters high. We have therefore indubitable evidence of the fact that the retreat of the ice only began after 1888. This is further confirmed by eye-witnesses. When the Rev. W. Spotswood Green explored the neighbourhood of Glacier House in 1888 it seemed to him that the ice tongue was advancing, for it had overturned some bushes at the northeastern extremity.

At the same time, however, the Rev. Mr. Green says that at the time of his visit all the glaciers in the Selkirks bore evidence of retrogression. He mentions the huge boulders which are met with on the road from the Glacier House to the glacier, and considers them moraines of an earlier glacier, made up of the Illecillewaet and Asulkan. The lofty tree trunks of the neighbouring forest would show the period of this giant glacier to be centuries ago, granting Green's explanation of the boulders to be correct. But there can be no doubt that the glacial high tide (Gletscherhochstand) of the end of the eighties has been preceded

by one of no long duration. This is shown by the brushwood that girdles the tongue. There must have been a state of affairs here not so long ago which hindered the growth of trees. The form of the land together with the numerous boulders, sometimes arranged like a wall, makes it certain that the glacier lay here at one time. Just how long ago can be estimated by the botanist who is familiar with the rapidity of the growth of plants in the Highlands of British Columbia. If it were in the Alps I should not hesitate to describe the brushwood-covered plain as the growth of some twenty years—it reminds one vividly of the bushes on the former site of the lower Grindelwald glacier. But the luxuriant growth of the primeval forest of British Columbia suggests the idea that everything grows more rapidly there than with us. Be that as it may, it cannot be so very long since that advance of the glacier took place to which the sharp boundary between brushwood and forest so plainly points and which is confirmed by the form and configuration of the land. It certainly belongs to our departing century. But it must have been the greatest advance for centuries, for it carried the ice forward to a wood with lofty trunks which, measuring at times two or three meters, must be centuries old. We have thus evidence in the distant Selkirks pointing to the same conclusion as in the Alps, viz., that the glacial advances in our century have been the most important for several hundred years.

Visitors to the Illecillewaet glacier are struck by the great purity of its upper surface, which is specially noted by Green. We have to do with one of those not uncommon glacial tongues which have no superficial moraines. This is no wonder, for the névé has no rocky masses behind, it fills a long valley up to a height of about 2,700 m. and has besides the Illecillewaet glacier to the north, an outflow to the west in the Geikie glacier. The same arrangement is repeated in a similar valley not far to the south, where the Deville snowfield supplies both the Deville and the Grand glaciers. These conditions bear witness to a peculiarly low snow limit on the rainy side of the mountains. This lack of upper moraines is by no means accompanied by a lack of ground moraines. On the contrary, the whole plain now free from ice is covered with them. Immense quantities of glaciated stones lie around; one sees the markings plainly on great boulders. This mass of material must have been brought along under the ice. Near to the edge of the glacier it seems as if it had been rolled with a broad roller. Broad, flat furrows are seen extending in the line of movement of the ice and separated by low-arched ridges. The two lateral moraines consist likewise of ground moraine material. So we have in the main the same conditions as those of the Sonnblick glacier which I described last year to the readers of this journal. We see again that the formation of the ground moraines is independent of that of the upper moraines. To those versed in the subject this is nothing new.

All the small glaciers that I saw about Glacier House are deeply sunk in their lateral moraines, and therefore seem to be retreating. The phenomena on the Illecillewaet glacier might therefore be generalized to a certain extent. Its special accessibility allows us to hope that it may often be observed in the future. It was therefore my intention to mark its position as observed on September 3rd, 1897.

But unfortunately there was no coloring matter or tar to be found either at the station or at the hotel. So I tried to sketch the position of the tongue in its relation to the surroundings as far as was possible by counting steps and the use of the compass. The result is the accompanying diagram on the scale of about 1:10,000.

I reckon the length of a step on the very uneven surface at 0.75 m. I determined the direction and the distance from the ice of three very marked erratic boulders, P₁, P₂, P₃ as well as of the Point (P₄) where the glacial creek leaves the space that is clear of ice. These are:

	For P ₁	P ₂	P ₃	P ₄
Magn. North	200° 72 steps.	N. 220° 26 steps.	N. 200° 20 steps.	N. 110° 225 steps.
True N.	226° 54 m.	246° 20 m.	226° 15 m.	136° 169 m.

I measured the heights with one of Naudet's large pocket aneroids. They are referred to the bridge over which the foot path leads to the glacier. Its height was 195 m. above the station Glacier. As the weather was uncertain this estimate, according to which the glacial tongue would be 1,461 m. high, can lay no claim to accuracy.

The tar marks made by Green I was unable to find. At P_7 however I saw a boulder with the mark COE. 1895, and at P_6 an arrow on a block. I could not find out who had made these marks. A railway labourer undertook to paint my marks ($P_1 P_2 P_3 P_4$).

The pictures on pp. 56 and 57 are prepared from photographs by Notman & Son in Montreal.* That on the left shows the glacier in 1888. The ice projects as far as the bushes and is still comparatively high in the arch. The one on the right, which I owe to the special kindness of Messrs. Notman & Son, was taken in October, 1897. The standpoint in both pictures is almost the same. Again one sees the high woods on the right and the girdle of lower brushwood, with the same inner border as in the other picture. But the ice has retreated. A wide strip of rubbish lies between it and the glacier. One can plainly recognize the great erratic boulders which are marked P_1 and P_3 . The tongue has not only receded, but is also very much shrunken. The lateral moraine on the left has at the same time increased in size. Above the rocky drift which separates the upper and lower glacial masses, the ice has also been retreating.

*These are not reproduced in this translation.

OBSERVATIONS MADE ON A TOUR IN CANADA. BY ALBERT PENCK.

A Paper Read on March 16th, 1898,

With 12 illustrations in the Text.*

*From the 38th Vol., No. 11, Society for the Extension of Natural Science, Vienna, 1898.**(Translated by D. R. Keys, Toronto, Canada).*

The British Association for the Advancement of Science met from August 18th to the 24th, 1897, for the second time on Canadian soil, at Toronto, on the north shore of Lake Ontario. The Government of the British Dominion of Canada and of the Province of Ontario, the Council and population of the city of Toronto, the great railway companies and all the scientific circles throughout the wide extent of British North America vied with one another in order to make the stay of their guests from the Mother country upon Canadian soil as pleasant and as instructive as possible, and in order to give them the most agreeable impression of the country. Connected with the meeting were extended excursions, partly in the neighbourhood of Toronto, partly under distinguished guidance across the continent as far as the island of Vancouver on the coast of British Columbia, the El Dorado of the present and near future.

A week before the meeting of the British Association for the Advancement of Science at Toronto, the American Society of the same name met from August 9th to the 14th, at Detroit, on the strait between Lakes Erie and Huron. It was a sign of the excellent relations between Britons and Americans that each society invited the other; first, the British were the guests of the American Association, which, realizing the pan-American idea, has members on both sides of the forty-ninth parallel, then the Americans attended the British Association, which represents the intellectual unity of the world-wide British Empire. Thus it was that within a short space of time an excellent opportunity was offered of meeting with American and British scientists in two places which, for that country, are not far removed from each other. While at Detroit a large number of American investigators had met with a considerable number of their British fellows, the meeting at Toronto offered such an assembly of British and American scholars as has probably never before taken place. One may say with confidence it was a meeting of the most eminent English-speaking scholars; one got not only the idea of a British world-empire, but still more of the actual existence of an English world-speech.

It was my privilege to be invited as an honorary guest to the British Association, and I also attended the American meeting in the same capacity. Never can I forget the days which I passed, first in Detroit and then more especially in Toronto, in a circle of illustrious men. The excursions connected with the British Association mark an extension of my geographical horizon such as I had never before experienced. But the recollection of all this scientific gain is rivalled by the memory of a truly magnificent hospitality which I enjoyed from my place of embarkation to the New World, that is, from Liverpool across the Atlantic and from its western edge across Canada to the Pacific.

The shortest, although not the quickest, way from Europe to Canada leads across the North Atlantic to the Straits of Belle Isle, which afford an entrance between Labrador and Newfoundland to the Gulf of St. Lawrence. By this summer route of the Canadian steamships from Liverpool to Montreal, one comes within 800 kilometers of Iceland and 500 kilometers of the south point of Greenland, and arrives at the most inhospitable part of the coast of America, that of Labrador. It is washed by the cold Labrador current, which bears the icebergs of Greenland away south to the Banks of Newfoundland. On the evening of August

* It is unfortunately impossible to reproduce the illustrations in this translation.

3rd, 1897, the *S. S. Laurentian* had reached this cold current. The temperature of the water, which is taken every two hours, fell suddenly, it became unpleasant on deck, and on the afternoon of the 4th the first icebergs came in sight. Three peaks arose from the waves like a mountain chain on the horizon. They shone with dazzling whiteness over the gloomy sea. Then a new one hove in sight further back. We came considerably closer to it and so it made a more imposing effect. Finally in the evening a magnificent white pyramid was sighted. The day after the cold current made itself felt by a thick fog, which lay heavy over the sea. The *Laurentian* had to stop frequently to avoid collisions with icebergs; several flocs drove past close by. By noon the observation showed us to be near Belle Isle, but no land in sight. The steamer stopped again and sounded the fog horn every twenty minutes. Finally in the evening, when the fog lifted a little, we saw the light of Belle Isle, after the cannon shots which we heard from time to time had made known to us already the nearness of this dreaded island. The captain, however, would not risk a night entrance into the cliff-bound straits, and we lay to again. The next day, fog again, the *Laurentian* advanced at "stand-by," in order to stop again presently. Then all at once a light streak became visible in the fog, and in a few minutes it was certain that the land was just in front of us. A dark mass of rock rose from the sea, the beach still spotted with snow, although it was only August 5th. Such is Belle Isle.

For a time we continued our way past ice-flocs and icebergs, gloomy land in the distance and an oppressive fog over it all. So the first impression of America at this point, where it is bathed by the waters from the Pole, was exceedingly unfriendly. Soon, however, upon entering warmer water, the weather cleared and the rest of the passage through the Gulf of St. Lawrence was very beautiful.

We seldom lost sight of land. In the north we saw the round humped mountains of Labrador, and of the northern part of the Province of Quebec. In the south the forms were quite different—long extended ranges with few divisions and high level plateaus on top. Such was the north coast of Newfoundland as we saw it during the rest of August 5th, and such too as seen on August 6th, were the mountains of St. Anne, 1200 meters high, on the peninsula of Gaspé, forming the southern shore of the long funnel shaped inlet which already at this point usually receives the name of the St. Lawrence river. On the northern shore rounded mountains about equal in height still prevail. We are here much impressed with the fact that we are travelling along one of the most important lines of disturbance in the geological formation of eastern North America. This is the St. Lawrence and Champlain line, which separates the primeval Laurentian land in the north, the protaxis of the American continent or the Laurentian shield, with its occasional covering of irregularly deposited palæozoic strata, from an old much-folded mountain chain composed of palæozoic rocks. By this contrast in form the journey up the St. Lawrence (whose waters are salt as far as Quebec) acquires a picturesque quality which is very attractive. The forest, which avoids the coasts of Labrador and Newfoundland, now comes down close to the sea in thick groves, only here and there destroyed by forest fires. Another feature of the landscape impresses itself at once on the attentive observer; parallel lines extend along the shore at varying distances from the water. Sometimes they appear as indentations in the declivity, sometimes as terraces in the openings of the little valleys of the precipitous Gaspé, as well as of the northern coast. These are the shore lines of an earlier sea, indented by the force of the waves, or heaped up by the rivers, after the great ice age when the land lay one or two hundred meters lower than to-day, and gradually but unsteadily rose with frequent interruptions. To every period of rest in its rise corresponds one of those terrace-like levels on which the Canadian French are so fond of building their little white houses.

Below Quebec at Grosse Isle is the real mouth of the River St. Lawrence, that is the place where the fresh water is severed from the salt. From here to Montreal the landscape is more monotonous, the mountains retreat on both sides and the shores become lower as we go further inland. The river itself often divides into numerous branches. Yet the journey is not uninteresting. Only we must not lose sight of the fact that we have travelled almost 300 kilometers up the river into the country on a great ocean steamer, and that the river has only by artificial means become the magnificent waterway that it is to-day. In various places canals have been made.

Our progress into the interior of the continent made itself apparent by an increase in warmth—August 8th brought great heat, all the more unendurable because a few days before we had been fairly frozen among the icebergs. In the winter, however, it becomes bitterly cold; every year the St. Lawrence freezes, and that so hard that they can carry the railway over it at Montreal. Still I could not discover any effect of the moving ice upon the form of the river bed, or upon the transport of boulders. The river bed has the same form as that of streams which have but little ice, and the accumulation of boulders on the shore is confined to places where the clay has been washed down. Near Lotbinière only, it rushes along between heaps of boulders, and evidently it here traverses a mass heaped up in its bed during the ice age.

At midday on August 9th I landed in Montreal after a journey by steamship of 5146 kilometers. I was strongly tempted to stay in the neighbourhood of this city, where a boss of eruptive rock breaks through the superincumbent Silurian strata to form Mount Royal, which again bears glacial marine deposits almost to its summit. But, it seemed to me more important to go on at once to Detroit in order to meet the American investigators. Thither I hastened, merely making a short stop in the capital of Canada for the purpose of viewing the collections of the Geological Survey of Canada. I had then for the first time the pleasure of meeting with its director, Dr. Geo. M. Dawson, who afterwards guided the great excursion across the continent.

In Detroit the opportunity, for which I had been secretly longing, arrived, that is to make an excursion under approved guidance to the shores of the great North American lakes. These waters are of sea-like dimensions, on their shores the waves wash down cliffs as on the coasts of the oceans and cast up beaches, while the current along the coast forms spits and sandbars. All these phenomena have been excellently described by Gilbert, and it was a matter of great importance to me to see them as well as a number of other phenomena. Above the present shore line, for instance, there extend others belonging to an earlier period of higher water levels. The investigations of Gilbert, Spencer and Taylor have shown that they are not parallel with the present water line, but have a regular ascent towards the northeast. This fact is theoretically of great importance, for it leaves but one deduction possible, that of a general rise of the land which was stronger in the northeast than in the southwest. Therefore American scientists speak quite confidently of great elevations of the land, of a warping, a bending of the earth's crust, while Ed. Suess in Europe gave quite another significance to the phenomena on the Scandinavian coast, and being dubious as to any general rising of the land referred them to a movement of the surface of the sea.

To my great good fortune Grove Karl Gilbert himself met my wishes and conducted me around the phenomena which he discovered and described. After attending the meeting of the A. A. A. S. on August 10th to 12th, and visiting some sunken valleys near Detroit under Taylor's guidance, I found myself on the 13th in Buffalo, where I was to meet Gilbert. We first visited the counties on the south shore of Lake Ontario in New York State, where, like the fingers of a hand a number of long narrow lakes lie between pleasant shores, then we travelled to the western extremity of Lake Ontario in order to proceed along its northern bank to Toronto.

At the very start our journey afforded us an interesting phenomenon. A long sandbar entirely separates the western end of Lake Ontario from the lake itself, so that a wide bay stretches along beside the inland sea. On this is situated the flourishing city of Hamilton, built upon a terrace which evidently represents an old lake shore. From this terrace a broad dike, thirty-four meters high, and scarcely forty meters wide on top, extends like a railway embankment towards the north, separating marshland from the bay already mentioned. It has been cut through in the middle, and one can see that it consists of coarse gravel resting on fine sand, underneath which lies clay. It is a recent accumulation that we have here. The inhabitants of Hamilton have no doubt as to its origin. They regard the dike rightly as the sand bank of a Lake Ontario which stood thirty-four meters higher and which created also the present site of their city. Beside this older sandbank runs a recent one that converts the west end of the lake into a great bay. From here on we followed without interruption the old shore line—Gilbert's Iroquois

line. Everywhere it is easily recognized, here as a cliff, there as a high strand line (strandwall), then again it develops into a spit or a dike—an old sandbank—across the front of a little valley. We were thus convinced that we were following the same higher shore continually. After following it for forty-five kilometers we measured its height at Cooksville, finding it forty-five meters above the lake, and when I was visiting the interglacial deposits at Scarboro' Heights with Prof. Coleman a few days later, I met the Iroquois shore line sixty-nine meters above the lake. It rises, therefore, thirty-five meters within a distance of seventy-five kilometers as the bird flies, that is to say in round numbers 0.5 m. per kilometer in a northeasterly direction. The old surface of the lake as shown by the Iroquois shore line is inclined towards the present one at an angle of almost two minutes. It is out of the question that such an inclination of a water surface could exist, or that at the time of the formation of the Iroquois line the surface of the lake could differ to such an extent from that of to-day. We must therefore assume that since the origin of that shore line the district has been tilted up by a movement of the earth's crust. This is the same movement indicated by the beach lines in the Gulf of St. Lawrence. Canadian geologists have found that the marine formations here ascend in the direction toward southwest. Their greatest height (250 m.) is reached in the neighbourhood of Quebec. This is the middle point in a great arch-like upheaval, which has affected the whole St. Lawrence region along with the great lakes of North America since the ice age, and which, as Gilbert has lately shown, is still going on.

The excursion with Gilbert, several trips around Toronto under Prof. Coleman's guidance, finally an excursion which a number of members of the British Association took to Niagara Falls on August 22nd, all gave me an excellent opportunity to learn the character of the shore of Lake Ontario. It is gently rolling and cleared to such an extent that only a few patches of the original primeval forest remain. Everywhere stretch waving fields of grain, the well-to-do farmers' houses are often hidden in orchards, and indeed even the vine is successfully cultivated in Canada in the Niagara Falls district. The soil is almost everywhere fruitful. It is formed for the most part from the glacial deposits of the ice age, which are distributed over flat Silurian strata. On the northern shore of the lake these strata are of shale, on the south they are of limestone, giving a configuration to the country like that of the Swabo-Franconian Jura. This is the Niagara limestone formation at the foot of which Lake Ontario occupies a position similar to that of the Neckar district at the foot of the Rauher Alp. At the point where the Brock monument is built upon it, giving a wide lookout, this peculiar situation of the lake was very well shown on Aug. 22nd by Prof. Wm. Morris Davis, the distinguished American physical geographer. He expressed the opinion that the land surface around Lake Ontario, as indeed in all the region of the great lakes (except Lake Superior) has the features of a steppe-like landscape formed by subaerial denudation, and not much modified by glaciation, although the latter, as the disclosures at Scarboro' show, has been twice repeated. It has blocked up the old water-courses, as for example, a valley that coming from the west emptied into the lake near Hamilton. The rivers have thus been obliged to find new channels, and have not yet fully cut them out. The mighty Falls of Niagara bear witness to the youthfulness of its course. It has not yet cut through the Niagara limestone formation.

The various trips on Lake Ontario were only a prelude to the great excursions which were arranged for the members and guests of the British Association after its close. There were four of them. They all had as their objective point the island of Vancouver on the west coast of the British Dominion of Canada, but to send all the numerous participants thither at the same time would not only have been mechanically impossible, but also from scientific reasons impracticable. For a scientific excursion to be instructive must be strictly limited in its numbers. Consequently the company was divided into groups, each of which had a specialist as guide. One left Toronto as early as the 26th, conducted by Dr. Wm. Saunders, director of the Experimental Farms of Canada. It was specially intended for botanists and geologists. The next day the geologists and geographers set out. Our guide was the distinguished geologist of Canada, Dr. G. M. Dawson, who presides over the Geological Survey with equal practical intelligence and scientific breadth of view. He had himself explored a great part of our route, and as the

geologist in America is generally obliged to take topographical observations, he was in every way a competent guide over wide regions whose geographical features had been recognized by him with great clearness. Moreover, his personal amiability and constant approachableness helped to make our long journey one in every way enjoyable. With him too was Dr. Coleman, Professor of Geology in Toronto, and State Geologist of the Province of Ontario, who likewise knows great stretches of our route by personal explorations. The C.P.R. assisted us by many favours and placed at our disposal a large sleeping car in which we lived the next nine days. There were twenty-seven of us. Among them I may name the former director of the Geological Survey of India, Dr. Blandford; Mr. Lamplough, of the Geological Survey in Great Britain; the mineralogist, Prof. Miers of Oxford; the Professor of Mining and Mining Inspector, Le Neve Foster; the explorer of Kafiristan, Sir George Robertson; and the explorer of the Amoor territory, Prince Kropotkin; further, the secretaries of the Geographical Societies of London and Edinburgh, Dr. Scott Keltie, and Colonel Bailey, the librarian of the London society; Dr. H.R. Mill, the Professor of Geography of Harvard University; Dr. W. M. Davis, the director of the Museum of Natural History in Manchester; Dr. Hoyle; Prof. Armstrong, the chemist; and the technicians, Prof. Beare and Dr. Harden of London; as well as the Breslau physiologist, Prof. Hurthle. Our two leaders and guides were assisted by the Canadian geologists who were working in the district. Mr. A. E. Barlow was awaiting us at Sudbury, and Mr. McInnes joined us on the road to Rat Portage. Finally in Banff we met with Prof. Macoun, the botanist of the Geological Survey. We had thus every opportunity of being shown a very great deal in a very short time. While our company was not of one profession, we were one in the eager desire for knowledge. The wives and daughters of some of the members accompanied us, and took a friendly interest in the magnificent landscapes and broad, scientific impressions which we enjoyed.

We first went north in order to reach the line of the C.P.R. The richly cultivated land on the north shore of Lake Ontario was soon left behind, and we entered the immense primeval forest which extends from the great lakes northward to Hudson's Bay. The boundary between the horizontal beds of the Silurian formation and their subjacent strata, the primeval Laurentian and Huronian rocks, has offered a barrier to the extensive progress of clearing, and will to all appearance continue to do so. The Laurentian land has been smoothed off by the glaciers of the ice age, stretches of bare rock appear in smooth, humped barrows, the hollows between filled with loose debris and boulders. This rock, however, does not produce a fruitful soil like the Silurian slates and limestones; it weathers very slowly, and since the ice age it has scarcely formed a humus. Besides the climate is very severe. The same conditions prevail as in Sweden and Finland, of which countries we are also reminded by the character of the extensive Laurentian forest. Rounded mountains of moderate height rise irregularly. Only here and there where they meet with specially hard rock do they take the form of ridges. Between stretch marshy plains or lakes full of islands, the only natural interruptions of the gigantic forest in which we travelled nearly 48 hours, almost 2000 kilometers.

A visit to a couple of mining districts on August 28th and 30th made a break in our long journey. At Sudbury, the point where the "Soo" line branches from the C.P.R. to Minneapolis, there is a rich deposit of iron pyrites on the boundary between the Huronian and Laurentian rocks. Along with the iron it contains copper and especially nickel, and is at present being worked with great energy. In the neighbourhood anthracite has lately been found in peculiar old slate deposits, upon which discovery the people of Sudbury are basing hopes that are probably too high. We were pressed by our amiable hosts to go there. An engine drew our sleeper some kilometers on, a stop was made on the line, and having taken to some rather rough wagons without springs, we continued our way to Vermilion Creek. Here we were divided up among a number of Indian canoes and heavy boats in order to row to Vermilion Lake. All the poetry of the Leatherstocking Tales at once came vividly back to mind as I was gliding forward upon the peaceful, mirror-like water between the trees of the primeval forest. Then our way led on by a narrow Indian path, a so-called trail into the lofty forest, now clambering over fallen tree trunks, now scrambling through them till we reached the spot in the middle of the woods where they were in the act of sinking a shaft. There

under noble trees stood a puffing engine and several men were working in the midst of that lonely forest at what seemed to me a hopeless undertaking. In the neighbourhood, however, some settlers had already taken up their abode on the good alluvial soil. The forest was burned over, only a few charred rampikes rose here and there; plain log houses were built in which, however, there was an air of comfort. We also came upon a school in the midst of the forest as we returned.

At Rat Portage also, on the boundary between Huronian and Laurentian rocks, gold appears. Consequently this little town at the northern end of the Lake of the Woods is growing rapidly and the lake is crossed by numerous steamboats. The principal deposit lies on a little island in the lake; this mine, the Sultana, was the object of an excursion for which we were as much indebted to the municipality of Rat Portage as we had been to that of Sudbury two days before for the trip to Vermilion Lake. A little steamer took us through the labyrinth of islands and narrow channels past Indian camps and burial grounds to the Sultana, where most of the labourers are Scandinavians. We had a jolly picnic, viewed the galleries and workings of the mine and then the active members of the party hurried to the highest point of the island which had already been cleared of wood. The view from above was wide and striking—the lake in the woods, the wooded islands in the lake, rising as smooth, polished, rocky humps like the point on which we stood, and a cloudless sky above it all. Toward evening we went to another little island where peculiar breccia appears in the Huronian slate, the so-called agglomerate; whilst next morning Prof. Coleman showed us Huronian conglomerate in the town of Rat Portage. They can be recognized as such at once on the surface of the rounded humps, but one cannot strike off fragments from them. They leave it certain that the material of the Huronian slate has here originated in the destruction of an old land. Undoubtedly we have in this case a clastic formation. However, the so-called Laurentian gneiss made the impression on me of a rocky mass, consolidated at a great depth, of a bedded granite somewhat like the Central gneiss of the Alps. The occurrence of the gold of the Sultana mine reminded me forcibly of that of the Hohen Tauern. There, too, the gold is found on the border between bedded granite and dark slate, the so-called Neuern, which is exactly like the Huronian of Canada. The exposures themselves did not seem to me, however, at all remarkable, only I was obliged to marvel how they could be discovered. This applies also to the nickel and anthracite of Sudbury. Only a very close investigation of the country could lead to their discovery. Such an investigation is in fact carried on by the “prospectors” who traverse North America in all directions even to the depths of the remotest forests in their search for iron and coal.

Between Sudbury and Rat Portage we came on the most beautiful landscapes of the Laurentian country which, with all its charms, is in general monotonous. In the night of August 28th-29th we crossed the watershed, some 400 or 500 meters high, between the Ottawa and Lake Superior, which latter we reached at noon the next day. The Laurentian country rises 200 or 300 meters above it and descends towards it with a bold fringe of precipitous rocks. Its valleys run under the water, the inlets of the lake extend far into the land. The railway winds along the shore for about 300 kilometers. Now it ascends the foot-hills from which a delightful prospect unfolds itself upon the sea-like lake which covers more space than Bohemia, Moravia and Silesia together; now it passes around charming bays in some of which are friendly havens.

A way had been prepared for it by the earlier shore line of the lake; the whole coast up to 120 meters above the level of the water is terraced in the plainest possible fashion by the old shore lines; gorges are to be seen in the foot hills, and piles of debris in the bays. It is the declivity of a mountain range along which we are travelling. But from the Nipigon Bay on the scenery changes. In front of the Laurentian heights with their irregular rise and fall, lie table mountains of a peaceful form. They consist of irregular beds of pre-Cambrian age, whose mighty tops are of trap. The boundary between this table mountain material and the Laurentian rocks is very remarkable. At the station, Mazokama, one can see how the latter is continued with its irregular upper surface under the former. One gets the impression that its typically characteristic irregularity dates from pre-Cambrian times. The same thing is seen in the northwest of Scotland, where the

irregular wavy surface of the old gneiss dips under the irregularly deposited cover of Torridonian sandstone. To this, too, the stratified rocks of the Nipigon Bay have the greatest resemblance. We have thus in two widely separated parts of the earth's surface indications of a pre-Cambrian land surface which was afterwards renewed.

Towards the west the rounded landscape of the Laurentians gradually disappears under younger formations. At the same time the forest growth recedes, it is confined more and more to the singly rising rounded hills and finally disappears altogether with these. The meadow land, which at first only appeared along the overflowed districts, begins to be the rule. Within about an hour's journey by rail, this transition from primeval forest to prairie is completed; Rat Portage is in the midst of the forest, Winnipeg, the capital of Manitoba, lies amid wide level meadows which take in the bottom of the former Lake Agassiz.

This is magnificent farming land, producing the very best wheat. Immense as was the forest before, the fields are now equally boundless, interrupted only along the rivers by wooded meadows. The land—an old lake bed—lies there as level as a table; the railway, no longer obliged, as in the Laurentian district, to wind in continual curves around the numerous rounded hills, now pursues its way as though it had been drawn with a ruler. Instead of stopping as in the forest once an hour at the little group of houses made up of station, hotel and shops, undeserving the name of village, the train now passes prosperous villages often inhabited by Scandinavians, and draws up every twenty minutes at a station beside which rises a huge granary or elevator. The harvest is just over. The fields are mowed in a week, the corn is already threshed and the elevators are filled. Meanwhile the news has arrived of a failure of the harvests in the old world. Joy reigns in Manitoba. They speak of millions that must pour into the land.

The journey continues about 100 kilometers over the almost level bottom of the old Lake Agassiz before the road, which at Winnipeg attained a height above the sea of 210 meters, rises as high as 250 meters. Then certainly a slope becomes apparent. We must ascend the plateau of the cretaceous formation which extends through Western Manitoba. We soon reach a height of 500 to 600 meters, and for 500 kilometers this level is maintained with scarcely an appreciable rise or fall as we descend into the valleys of the rivers or ascend the water-sheds. The soil is still as fertile as before; alluvial clay prevails. It has just been turned by the plough. Here and there we meet settlements with good prospects such as Regina, the capital of the District of Assiniboia. Further west the land changes. Previously level or rolling it now becomes hilly. It consists of a number of closely crowded eminences separated by level marshes.

One perceives at the first glance that the Missouri coteau which we cross between Mortlach and Ernfold is a true moraine landscape. But how different it appears here where it lies in a dry climate, from what it is in our richly watered land. Not a pond, not a pool, not a bog between the hills, nor any forest on them, not even a tree or bush; no little brook winding its way through the landscape; only a monotonous "up and down" covered by a comfortless steppe. For miles the dry vegetation is burnt away. The land is black with its charred remains; only the white erratic boulders gleam ghostlike from the black plain. Here and there where the water has been able to remain some time on the level, a little green appears, the white crusted plains beside it are the remains of a dried up salt marsh. A group of larger salt lakes, the Old Wives lakes, persists from year to year; the bottom of a freshwater lake now drained (Rushlake) serves as a farm. Not a house is to be seen for miles, perhaps once an hour the train stops at a wretched station. In other respects too the land is desolate, since the herds of buffalo which once inhabited it have been slain. At the station one sees great piles of their bones which have been collected on the steppe to be ground into bone meal. The very bare desolation of the land, however, aids us even in passing to get an idea of its structure. Several groups of moraine ramparts can be recognized, sometimes having a heap of debris lying in front of them. One is strongly reminded of the Alpine relationships; but the whole Missouri coteau seemed to me like a dried up Baltic lake plateau.

This great terminal moraine rampart, like its European equivalent, does not

indicate the end of the moraine formations. For not less than 500 km. to the west up to the foothills of the Rockies there is erratic material of Laurentian origin, such as boulder clay with polished stones. But the predominance of these glacial forms in the landscape is past. They become secondary features of the scene, the chief features of which receive their character from the irregularly laid cretaceous, and superimposed old tertiary (Laramie) strata. The latter form table rocks between the valleys, *e.g.*, the Cypress Hills, which bear the only forest in a wide circumference. A zone of moraines covered with loess is not present; the loess in America as in Europe does not reach above 300 to 400 meters. From the Missouri Coteau, which marks an ascent of over 100 meters, the C.P.R. keeps at a level of over 700 m.; only at Medicine Hat, where we cross the Saskatchewan, does it descend to 655 m. This is the great steppe country on the east of the Rockies—a land that offers the best prerequisites for cattle raising. The cattle here are replacing the buffalo, which is extinct. On the literally immeasurable plains one still sees tribes of Indians with wagons and some cattle wandering on their broad paths.

Yet even this is but an artificial accident in the natural scenery, which with all its uniformity makes a deep impression on the most rapid traveller. When the sun sinks and its parting beams suffuse the dry hills with a subdued glow and the shades of night creep into the hollows while the western sky is still gleaming with bright gold—it is then one feels the indescribable magnificence of this scenery and learns to comprehend that the dweller on the steppe loves his poverty-stricken land scarcely less than the sailor loves the sea. This landscape, indeed, is somewhat like the sea.

In the night of September 1st-2nd our sleeper was uncoupled at Calgary from the transcontinental train in order to be taken on to the Rockies after daybreak as a special train. Clear and sharp on the western horizon of the capital of Alberta was descried the broken rocky wall, forming in truth the Rocky Mountains.

If one could imagine the Karwendal chain advanced to the very border of the Upper Bavarian plateau, one might get such a view as we had during our subsequent ride, now from the windows of our sleeper, now from the windows of the caboose, and above all from the locomotive itself, in all parts of which our members had posted themselves in order to admire the magnificent mountains. Their vicinity was proclaimed by the geological formation of the land through which we were passing. Strata of the cretaceous system which had accompanied us so far in flat deposits appeared upright and in some places in a folded position. They form a few not very high ridges parallel to the mountain chain, the so-called foothills which take the place of a foreland to the mountains. After a journey of 80 km., during which we had only ascended at the Bow river 200 m. above Calgary (*i.e.*, 1,250 meters altogether), our train stopped on an open stretch at the foot of the Rocky Mountains. Before us rose its bare, bald walls to a height of 1,000 to 1,500 meters. They consist for the most part of palæozoic limestones which have been shoved out over the cretaceous strata of the foothills. At the same time they have been pressed together confusedly whilst the former just at this point have been only slightly disturbed. On the border of the Rockies one sees old rocks turned upside down some kilometers away above the younger ones, and this fact lends a peculiar interest to the profile of the Kananaskis.

After a short stop we went on through the gate of the Bow river, "The Gap," into the mountains which here show a rare regularity in their geological structure. Every chain represents a block of Devonian-carboniferous strata which is raised in the east and declines in the west. In consequence the same succession of strata is repeated over and over again as is typical for the isoclinal structure. Between these palæozoic stratifications extends a trough of cretaceous deposits which the Bow river follows for some distance to the neighborhood of Banff. The palæozoic strata encroach upon it again from the west, as one can plainly discern from the profile of the three peaked mountain which bears the name of the Three Sisters, (2,957 m.) Not far away is the highest mountain of the region, Wind Mountain, 3,170 m. high. These lofty peaks exhibit the forms of great mountain chains. The intervening valleys are broad and level, having their sides bordered with moraines. The latter attach themselves to the slope of the mountains stretching away in a regularly curved talus. At the same time they support the beautiful

forest of that region whose farthest outposts extend to a height of 2,400 meters, *i.e.*, somewhat higher than in the central Alps which are 4° further south. Perpetual snowfields are confined to the very highest peaks. In this region is the Canadian National Park, its central point is the little town of Banff, where our excursion spent September 2nd. Soon after our arrival the more active hastened to Sulphur Mountain, (2,270 m.) It is a typical isoclinal mountain, with its peaks breaking off precipitously to the east and the surface of the strata, which might belong to the carboniferous (I found a productus on the top), sloping less steeply to the west. The summit is rounded as may be seen from a photograph taken by Prof. W. M. Davis. The glaciers of the ice age passed over it and left relics of the moraines. On the east at its feet lies the well wooded valley of the Spray, 900 meters deeper. Here bubbles up the warm spring which gives the mountain its name of Sulphur Mountain. It probably indicates the line of cleavage east of which the strata buckle up again into the Rundle mountain, (2,980 m.) To the west beyond the wooded Sundance valley, there rises another isoclinal rampart, the Bourgeau range (2,990 m.) Here cirques have been cut in the mountain ridges, between them the forest ascends much higher on the sides of the mountain than in the domain of their débris-filled floors. A portion of the valley of the Bow river running in a transverse direction cuts off the sulphur mountain and its neighbours to the north. In the broad, woody valley the river meanders along with many windings and in several places backs up so as to form a lake, while beyond rise new isoclinal mountains, among them the splendid rocky form of Cascade Mountain (2,986 m.) This transverse valley continues to the east, but on reaching the trough of cretaceous formations above mentioned the Bow River leaves it. Evidently it once followed this valley through the Devil's Gate out into the plain. The magnificent surface of Lake Minnewanka (Devil's Lake) some distance away indicates its deserted course.

For a long time we remained on the top of Sulphur Mountain lost in the contemplation of the magnificent beauty of the panorama. The almost geometrical regularity of the stratification, which showed only here and there by slight curves, as at Cascade Mountain, that it is due to a folding process, impelled one irresistibly to the consideration of the problem of mountain formation. But the geographer was enchained no less by the regularity of the internal form, the alternation of almost rectilinear valleys both longitudinal and lateral, and many peculiarities in the course of the valleys. Indeed the outermost advance post of Rundle Mountain is quite cut off by the Bow River as the Tunnel Mountain. The opinion was generally expressed that it is scarcely possible to imagine a finer field than the neighborhood of Banff for special study in stratigraphic geology, geotectonics and geomorphology. The basis has been already laid by the topographical and geological survey of Canada. The former prepared a special map of the National Park on the scale of 1 to 40,000, the latter had a transverse profile taken through the whole Canadian Rockies so as to cut through the region about Banff, by R. G. McConnell, and Dawson himself has explored the neighbouring cretaceous trough. At the same time the C.P.R. hotel offers headquarters comfortable enough to satisfy the claims of the most exacting.

From Banff the railway continues up the Bow river, then for a short distance in the transverse valley mentioned above, then again in a longitudinal valley running close by the watershed here formed by the Rockies. In the west one sees their proud snow covered heads which now regularly exceed 3,000 meters in height and bear considerable glacial areas on their shoulders. Mount Lefroy 3,353 meters is the highest. That the chain rises further north to 4,785 meters in Mount Hooker, and even to 4,880 meters in Mount Brown, as is given on our maps, is very much doubted by Sulzer and Hueber who during their journey among the Selkirks nowhere saw any such giants rising from the Rockies. The Hector Pass, a very narrow gateway 1,614 meters high, affords a passage from the Hudson Bay Territory to that of the Pacific. This height is easily attained from the east. We follow the Bow river to Laggan (1,503 m.) without having any real engineering difficulties to conquer, with an average ascent of only 2.8 per cent. Even then it is only a matter of ascending 111 meters in a distance of 11 kilometers, and we are in a saddle in which many cones of deposition display themselves. But then we must descend 348 meters in only thirteen kilometers. This is undoubtedly the

magnificent portion of the whole C.P.R., where the train in three quarters of an hour running time with a fall of 27 per cent. loses all the height it had gained from the foot of the Rocky Mountains. Slowly it glides down the steep slope, incessant is the grinding of the brakes. Only with difficulty has room been found for the road on the steep rocky walls which descend to the foaming and rushing Kicking Horse River. It pierces through them in tunnels and leaps from one side to the other on lofty bridges. The deeper it descends, the higher rise the mountains; at Field our next stop we have the beautifully formed pyramid of Mount Stephen (3,188 m.) rising almost 2,000 meters close above us.

The stratification of these highest portions of the Canadian Rockies is comparatively simple. Enormous Cambrian strata appear to lie almost as they were deposited. In consequence they recall to some extent the Ampezzaner Dolomites, the names often indicating their regular architectural structure: thus we have a Castle and a Cathedral mountain. They offer difficult problems to the climber; in the neighborhood of Laggan the first accidents of Canadian mountaineering have happened. Further west near the Columbia river the mountains become more irregular in their build. The fall of the strata becomes more precipitous and is almost exclusively eastern. At the same time Silurian deposits appear, hemmed in by the Cambrian ones. According to this the structure of the Rockies taken as a whole is about as follows: Younger palæozoic strata, Devonian-carboniferous in the east and Silurian in the west, dip on both sides towards the middle of the mountains. There we find the oldest palæozoic rocks prevailing in more or less irregularly disposed undulations. But this holds good only for the Rocky mountains in Canada. When I crossed them afterwards on the Great Northern Railway, south of the Canadian boundary, I found only strata inclining to the east. The whole zone of the chain as at Banff is lacking at the Maria Pass. In the valley of the Kicking Horse River we descend from Field at first rather rapidly, and from the many windings of the road we enjoy various splendid views of the proud glacier bearing peaks of the Rockies. Then we enter a narrow gorge whose walls rise threateningly several hundred meters above us. The road winds so that we can occasionally see the whole train from our car window. Nowhere any inhabited places, the stations are only watchmen's houses. Then all at once another picture. We come out of the narrow gorge into the valley of the Columbia river, lying only 770 meters above sea level. It is broad and wide, along its slopes stretch broad terraces like the Mittelgebirge in the valleys of the Inn and the Adige, a heavy forest covers its floor which the river traverses in many windings. One has the impression of having reached an important boundary line in the mountains. As a matter of fact one has on the east the Rockies formed exclusively of palæozoic strata, and on the west rise the various chains which Dawson calls the Gold Ranges. They conceal the rich gold deposits of southern British Columbia, especially the Kootenay district, only recently opened up, in which the town of Rossland arose in the shortest time on record, as well as the older Cariboo district. Also the Klondyke of the north, which was opened up last summer and electrified all America, seems to belong to this zone. There appear in it, alongside very old sediments perhaps belonging to a pre-Cambrian age, also archæan rocks. Our line of demarcation may be followed morphologically for a long distance. From Donald, where we are first convinced of its significance, we can follow it on the map for 700 kilometers in a northwest direction, as a great longitudinal valley to which the Upper Fraser and the Peace River belong, and in a southeast direction to the Upper Kootenay and then into the valley of the Flat Head River for another 600 kilometers at least. This is a magnificent parallel to the great valley-gorge which separates the northern Alps from the Central Alps, and the resemblance holds good also as to scenery.

If the journey through the Rockies reminded me often of the Alps, now of the Alps in North Tyrol, now of the Kofel of the Dolomites, the rest of the journey through the first of the Gold Ranges, the Selkirks, reminded me often of the Brenner road. The railway passes through a narrow defile, such as seems to characterize the openings of the tributary valleys of the Columbia River, into the Beaver valley. Then it runs along the slope of the now widening valley, strikes into a neighbouring ravine and after an ascent of 540 meters, distributed over thirty-

two kilometers, we reach the Rogers Pass (height 1,310 meters), a deep saddle in the mountain, while the peaks rise steeply on both sides to a height of 2,700 and 2,800 meters. An outlet between the precipitous walls seems scarcely possible; then all at once the train rounds a corner and far below it appears the Illecillewaet River, to which it must now descend in great loops, passing frequently over high frail-looking trestles. As we do so quite a surprising mountain panorama is unfolded. Glaciers here recline against mountains only 2,700 meters high, and in the neighbourhood of the highest peak of the group, Mt. Sir Donald (3,250 meters), they cover considerable space. A turn of the road brings us quite close to the magnificent Illecillewaet glacier whose tongue only ten years ago reached immediately up to the lower shrubs, from which it has now retreated a distance of almost 170 meters. Not far from this glittering tongue, which is remarkably free from debris, rise the mighty giant trees of British Columbia. Evidently the snow line is here very low. Its height must be reckoned at 2,200 or 2,300 meters, that is lower than upon the summit of the Rockies, where it must be put at 2,700 to 2,800 meters, and far deeper than on the eastern edge of the chain, where peaks of 3,000 meters in height fall below it. The snow line sinks considerably from the interior of Canada to the Pacific. At the same time it is much lower on the west side of every chain than on the east side.

As at Banff in the National Park and at Field below the Hector Pass, so, too, at this supremely picturesque point, the C.P.R. has built an excellent hotel near the station Glacier, only a few kilometers from the end of the Illecillewaet glacier. This place is frequently made the headquarters for mountain tours in the Selkirks as well as being an excellent point to break the long continental journey. Our excursion also stopped here, but bad weather prevented us from making any use of September 4th. We were obliged to content ourselves with a visit to the tongue of the Illecillewaet glacier, of which I gave an extended account in the *Journal of the Alpen Verein* for 1898.

As at the Hector Pass, so, too, at the Rogers Pass the ascent from the east is easier than the descent to the west. The westward flowing river is in both cases the stronger; it works away with energy at the deepening of its upper channel and as at the Kicking Horse River, so, too, at the Illecillewaet the railway has difficulty in reaching the level of the valley. This is done by a fall of fifteen per cent. in a stretch fourteen kilometers in length. Then road and river descend together until the latter must enter a deep defile to reach the Columbia. It was here dammed up very high with driftwood. The track follows it with difficulty. At Revelstoke both have got down to the level of the great water-artery; it has circumvented the Selkirks in a great curve to the north and descended to a height of 450 meters in doing so. This is a level which we had passed away back on the prairies near Winnipeg, 1,200 kilometers from the eastern foot of the Rocky Mountains, and higher than this we scarcely get as we continue our journey westward. Even the chain west of Revelstoke, with its glaciers and peaks 2,700 meters high, which separates the waters of the Columbia from those of the Fraser river, is crossed in the Eagle Pass at a height of only 610 meters. Here we pass quite gigantic moraines with quite enormous erratic boulders.

The valleys within the Canadian Cordilleras lie considerably deeper than the prairie and steppe-land on their eastern borders. At the same time they are partly submerged, that is, they are occupied throughout their entire breadth by long and deep lakes, which not only follow the long valleys, especially in the region of the Columbia River, but also often assume very complicated shapes; the Shuswap Lake, which the Thompson River drains into the Fraser, reminds one, for instance, of Lake Lugano. Great deposits of sediment, as well as old deltas and shore lines, of which we counted not less than six at Revelstoke, reveal the fact that these lakes were once far more extensive. These deep valleys, rich in lakes, are really confined to the Canadian Cordilleras; farther south in the United States the space between the Rockies and the Sierra Nevada has not been broken up into valleys but appears as a uniform unbroken highland. This difference may probably be attributed to climatic causes. The Canadian Cordilleras are richly watered and supply mighty rivers. The regions to the south are dry and have no channels that reach the sea. But in consequence they have no way of being cut through, while such a power is working in the Canadian Cordilleras to a great extent and, as its

results, the valleys, prove, has been operative in the past also. This cutting up of the Canadian Cordilleras in comparison with the American is under such circumstances an indication that the general arrangement of the rainy districts on the west side of the Pacific has experienced no essential change for a considerable time but only oscillations.

It was already evening when we passed the Shuswap lake on the 4th of September, and that night we went past the Kamloops lake. Thus those of us who did not return by the C.P.R. lost the impression made by these great lake surfaces with their peculiar surroundings which form the rather dry plateau of the Canadian Cordilleras, lying enclosed between the Coast Chain and the Gold Range, an outpost of the great arid territory of the United States and like this latter distinguished by the outcrop of late volcanic rocks. On the morning of September 5th we found ourselves far down on the Fraser River which, for a while, follows a cretaceous trough on the eastern border of the Canadian Coast Range. These mountains rise not far from its banks to a height of 3,000 meters. But their proud heads were concealed in the clouds; our view was confined to the valley which indeed had enough to offer us. As a mighty stream the Fraser rushed along; we follow it upon a terrace of varying height. In several places, as for example at Hellgate, the valley narrows to a gorge, its walls rise over 1,000 meters from the river, which above such places seems to be dammed up, and has left plain highwater marks twenty meters above its September level. Laboriously and by astonishing feats of engineering skill the railway finds room. Here and there in the distance one sees Indian camps, inhabited by fishing parties and surrounded by platforms full of dried salmon. Besides these there are Chinese immigrants. They travel in bands along the railway line. The forest grows more and more luxuriant, the single trees rise like giants. Everything combines to make the journey through the Fraser canyon, as the magnificent valley is called, a most magnificent one, full of unique experiences.

The Fraser River gives the C.P.R. an outlet to the sea. It finds its way there south of the Canadian Coast Chain, where this range makes an obtuse angle with the North American Cascade Range. At this point it has descended to a level less than sixty meters above that of the sea and is bordered by broad alluvial plains. The projection of its great delta lies in the above-mentioned obtuse angle. Here rises beside it the volcano Mt. Baker, 3,256 meters high. A heavy rain shower as we were passing deprived us of this fine scenery; our view was confined to the delta, in whose great gravelly masses were embedded numerous tree-trunks which the river had brought down. A dense and lofty wood extended originally on all sides, but is now already cleared to a considerable extent. Here in an angle of the Straits of Georgia which the River Fraser has not yet filled up is the city of Vancouver, and here in a forest of gigantic trees still preserved in part, and within sight of the mountain is the terminus of the Canadian Pacific Railway. The line across the continent from Montreal to this point measures 4,677 kilometers; it is a journey of five days and six hours. Of this 946 kilometers and thirty hours' travel are taken up in traversing the Cordilleras. Certainly the longest mountain road in the world and everywhere uncommonly beautiful, more than three times as long as the longest of the Alpine railways—the Brenner line.

A large river steamer brought us from Vancouver through the Georgia strait in eight hours to Victoria, on the Island of Vancouver, the capital of British Columbia. It was an uncommonly instructive journey. The sky cleared, and the continental Coast Chain, 2,000 meters high, and the almost equally high mountains on the Island of Victoria became partially visible; between them we glided along over a surface smooth as a mirror, approaching a few small islands, which consist of evenly deposited cretaceous strata, and passing rapidly by the low alluvial land. All the banks are bordered with driftwood, brought down by the Fraser to the sea, which its muddy current troubles for a long distance from its mouth. By this one could realize vividly the geographical conditions under which originated the cretaceous strata that traverse the Canadian Cordilleras. They must have been deposited in narrow arms of the sea like the Strait of Georgia, in the neighbourhood of great river mouths which provided the wood for their coal deposits. Thus the present topography of the country still preserves features of times long gone by.

I got a very convincing assurance of this by a visit to the Nanaimo district and the Wellington coal mine, on an excursion participated in on September 7th by all the members of the various parties which had now re-united in Victoria. There at Nanaimo I saw conglomerates, which were evidently the product of the rolling action of the stream, old river pebbles, and I collected at the rubbish heaps by the coal-pits impressions of the leaves of trees. Nothing here indicates the nearness of the cretaceous sea, but south of Nanaimo in the same complex formation a rich marine fauna has been found.

The trip from Victoria to the above-mentioned coal district marks the end of my journey in Canada. Once more it led through a highly interesting landscape. The Island of Vancouver, which forms the fifth zone of the great Canadian Cordilleras, only partially rising above the waves, is covered in its deeper parts with a forest, the equal of which it would be hard to find. The Douglas firs, sometimes 100 meters high, form dense groves; with the prevailing dampness, forest fires, of which the Rocky Mountains afford many sad traces, can hardly arise. The train steams along under giants centuries old; only in a very few places have clearings been successful. They still rise in close proximity to Victoria, where the friendly and comfortable frame houses of the European settlers have a dwarflike appearance beneath them.

Here in Victoria where the excursionists enjoyed the friendly guidance of the inhabitants, there are still very striking traces of the glaciation of the ice-age, which, proceeding from the continent, covered the lower parts of Vancouver Island with ice. It crossed the fjord-like bay which forms the geographical reason for Victoria, at a right angle and therefore the bay cannot be considered the work of the ice. It is a submerged valley which shows that a sinking of the land has taken place. This sinking has now changed into a rising. The coast between Victoria and Nanaimo is accompanied by extended terraces. Thus we have on the Pacific coast the same phenomena as on the Atlantic shore of the great British Dominion in North America. As far as the traces of the ice-age extend the coasts are embayed, the outlets of the land valleys are under water and we find at the same time shore lines which betray the fact that a rise has taken place since the ice period. It has not been strong enough to obliterate the effect of the preceding sinking. The land that is in process of rising has the outlines of one that has been submerged.

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CANADIAN SURVEYS AND MUSEUMS AND THE NEED OF INCREASED EXPENDITURE THEREON. PRESIDENT'S ADDRESS. BY B. E. WALKER, ESQ., F.G.S.

(Read 11th November, 1899.)

We find ourselves possessed in Canada of a country vast in its dimensions, but of which the population is as yet comparatively small. If, therefore, we have good reason to believe that the natural resources of our territory are in any respect commensurate with its area, we may look forward with confidence to a great future. But in order that this may be realized properly and soon, we must devote ourselves to the exploration and definition of our latent wealth, and to the solution of the problems which inevitably arise in the course of its utilization under circumstances which are often more or less entirely novel. For this purpose we are provided at the present day with methods, appliances and an amount of accumulated knowledge not previously thought of, but which we must be prepared to enlist in our service if our purpose is to be achieved.—George M. Dawson, C.M.G., etc., Director Geological Survey of Canada. Presidential Address, Royal Society of Canada, 1894.

It is my intention to confine my address to the subject of national surveys and museums. If a private individual were to become the owner of five or ten thousand acres of diversified virgin territory he would, presuming that he was what we call a practical person, make or have made a careful examination of his estate in order to know its resources and possibilities. He would keenly examine the various soils as to their suitability for agriculture, the timber as to its immediate or prospective value, the clays and sedimentary rocks as to possibilities of building materials; or if his estate lay in a mineral area he would look eagerly for an Eldorado. He would consider the lakes and streams and the water powers and watersheds of his property, and the nature of the drainage or the necessity of artificial drainage. In a word, he would take stock of his purchase just as a merchant or manufacturer would of his goods. Now, a new country is but an enlargement of this diversified five or ten thousand acres, and the people of a new country are but an enlargement of this practical individual. If they are as able to recognize their interest in the national problem as he is in the individual problem, they will wish to know of what the national domain consists, what are its resources and its future possibilities. Clearly, they will wish to know what can in any particular part of the domain be first and most profitably marketed or put to use in manufacture as raw material. Just as clearly they will want to know what raw material they possess which although not marketable now will eventually help to build up the national wealth. Also if they are reasonably intelligent they will desire to know the extent of the so-called waste places which have apparently no present or prospective use or value measured by money. I need not tell you that at this moment I cannot stop to discuss the enormous value to man of the waste places of mother earth, so dear to the artist, the sportsman, the naturalist, and the truly intelligent man of any class. I have purposely begun by making a bald statement in defence of national surveys which will be admitted by all because it is based on economic grounds which are recognized by all, and it will be a surprise to many to be told that clear

as is the truth of this bald statement, we possess within easy distance from long settled districts vast areas about which we know nothing, or nearly nothing. For some of this ignorance there is adequate excuse; for much of it there is no excuse whatever. But in addition to the knowledge which is so clearly due to the people on economic grounds, there is knowledge, much of which upon a wide consideration of national interest it would be a true economy to possess, but which may be better understood by being regarded as what is due to the intelligence of the people rather than to their pockets. As an intelligent people we are entitled to learn gradually all that there is to be known about the natural phenomena of our country, and as an intelligent people we are entitled to possess museums in which may be exploited, not only the materials for national wealth, but also the entire range of natural phenomena as far as it can be exhibited objectively. Doubtless, no one in this particular audience will question this last statement, but we should always keep before us the fact that in a new country the majority of the people have their minds filled with material considerations alone. They or their parents have begun life, if not literally seeking their bread, still having as the main purpose the improvement of the material circumstances of their lives, and so it happens that they are deaf to any but what they deem practical arguments. The politicians reflect the people and it is therefore much more difficult than would at first seem natural to obtain a hearing for any expenditure of money which will only indirectly benefit the people. But while this is inevitable in the early days of a country struggling with poverty, it is disgraceful in any country to continue to neglect the higher considerations of national life when there is no longer the excuse of national poverty.

I should like this evening to consider with you what national and provincial surveys should accomplish, and what national and provincial museums should contain, and whether there is any longer a shadow of excuse for Canada persisting, as it has for so long a time, in neglecting these duties.

And first it may be well to review some of the work done in the past by which we have become better acquainted with our country. I shall refer almost entirely to work done by those who were in the public service, whether of Great Britain, the old Provinces, or the Hudson's Bay Company and other fur-trading companies, with only passing remarks on others whose work had no official origin.

In 1814, Admiral Bayfield, his duties in connection with the war being over, began a survey of the Great Lakes, which after the labour of many years resulted in the series of charts covering the entire St. Lawrence system of lakes and rivers and parts of our Atlantic sea-coast, on which charts so much of our navigation still depends. He also found time about 1830 to publish in the first volume of the journal of the Literary and Historical Society of Quebec, papers on the geology of Lake Superior and on coral animals in the Gulf of St. Lawrence. Major-General, then Lieutenant Baddeley, and Sir Richard, then Captain Bonnycastle, both of the Royal Engineers, appear also to have been students of geology, and both contributed papers to the early volumes of the same journal, the services of the former being used, according to Sir William Logan, in a public capacity. He was the first to write regarding the lower Silurian limestones about Lake St. John and Murray Bay, and some of our early knowledge of the Labrador Coast and the Magdalen Islands, is due to him.

About the time when Bayfield was surveying the Great Lakes, Prof. A. Lockwood, who was styled "Professor of Hydrography and Assistant Surveyor-General of the Province of Nova Scotia and Cape Breton," was surveying the coast and harbours of that province, the result of his labours being published in 1818.*

We are not so much concerned with mere topography, but it is interesting to note that Major Samuel Holland, Surveyor-General of British North America, who, as early as 1768, was working out the latitude and longitude of Cape Breton, was the uncle of Lieutenant-Colonel Joseph Bouchette, who was also Surveyor-General and did considerable work regarding the Maine boundary in connection with the Boundary Commission under the Treaty of Ghent, and whose topographical and statistical volumes on the various eastern provinces are so well known.† From our

* Brief Description of Nova Scotia. A. Lockwood, London, 1818.

† 1 "The British Dominions in North America," etc. J. Bouchette, 2 vols., London, 1832.

2 "A Topographical Dictionary of Lower Canada." J. Bouchette, London, 1832.

point of view the services to science in Canada of Dr. John J. Bigsby, who had been commissioned in 1819 to report on the geology of Upper Canada, and became in 1822 Secretary to the Boundary Commission already mentioned, are more interesting. While Colonel Bouchette travelled about the more settled provinces, investigating seigniori boundaries, statistical conditions, and matters mainly incident to the settlement of the country, Dr. Bigsby pushed his way into the wilder parts. He appears to have examined with more or less detail the geology of Lakes Huron, Superior, Simcoe and Nipissing, and the main river systems in connection therewith. The twenty-seven papers written after his return to England and contributed to scientific journals, as shown by the Royal Society Catalogue of Scientific Papers, down to 1873, treat almost entirely of North American geology. He published in 1852 a popular illustrated book in two volumes about Canada, and it is safe to say that in the northern part of Lake Huron he laid the foundation of the knowledge which resulted half a century later in his *Thesaurus Siluricus*.^{*} His "Notes on the Geography and Geology of Lake Huron," London, 1824, appears to be the first geological report of an official character regarding any part of Canada.

Before dealing with a later period in Eastern Canada we must turn to that great western territory which only came under our control after the Confederation of 1867. Year by year we are becoming acquainted with it, but for a hundred years before the members of our Geological Survey began to thread its wilds it had appealed to the imagination of a few by its very remoteness from civilization, and the volumes published by the most famous of its explorers are therefore fairly well known in literature.

In 1769 the Hudson's Bay Company issued a letter of instructions to Samuel Hearne ordering him to undertake an "expedition by land towards latitude 70° north, in order to gain a knowledge of the Northern Indians' country," etc. From 1769 to 1772 inclusive, Hearne made several journeys, the main object being the discovery of copper mines and to try once more for the North-West Passage, so long and anxiously sought. Before his day, as since, the Company had been accused of being lacking in enterprise and disposed merely to buy furs and keep the country as much a *terra incognita* as possible, but this idea Hearne in the introduction to the account of his travels, endeavours to refute. The published account† shows that in 1770 after a short journey in 1769, Hearne travelled from Churchill into the not far distant country of the Doobaunt and Kazan rivers and back, thus covering part of the barren-lands country through which J. B. Tyrrell travelled on behalf of the Dominion Geological Survey in 1893-94.‡ On his return Hearne immediately set out again and travelling first westward, thus avoiding the barren-lands country, and then northward, he eventually reached the Coppermine River. He recorded little of geological interest but devotes an entire chapter to the description of the animal and vegetable life observed by him. For various reasons his geographical work is out of its reckoning, but apart from the mapping done by Tyrrell it constitutes all that we know about an enormous area of Canada west of Hudson Bay.

In 1789 the active competitor of the Hudson's Bay Company, the North-West Fur Company, sent Alexander Mackenzie who had been for some years factor at Fort Chipewyan on Lake Athabasca, on a journey of exploration, doubtless suggested by himself. We all know that he followed the Mackenzie River to its mouth and returning set out from Lake Athabasca again in 1792, this time up the Peace River to its source, crossing the height of land and reaching the Pacific Ocean at about the fifty-second parallel. Sir Alexander Mackenzie was neither geographer nor naturalist, indeed he was only a trader, but he was one of the men who subdue empire and enrich their country in the effort to enrich themselves. His observation of natural resources and of the highways possible for commerce was very keen and whether it has a reasonable connection with my subject or not, I cannot forbear quoting some remarkably prophetic words, from the closing pages

^{*} "Thesaurus Siluricus. The Flora and Fauna of the Silurian Period." John J. Bigsby, London, 1868.

† "Journey from Prince of Wales' Fort in Hudson's Bay to the Northern Ocean," etc. Samuel Hearne, London, 1795.

‡ "Report of the Doobaunt, Kazan and Ferguson Rivers and the North-west coast of Hudson Bay," etc. J. Burr Tyrrell. Geol. Surv. Can. Annual Report Vol. IX. 1896. (Published in 1897.)

of the account of his travels.* After a careful discussion of waterways he concludes as follows :

"By opening this intercourse between the Atlantic and Pacific Oceans, and forming regular establishments through the interior, and at both extremes, as well as along the coasts and islands, the entire command of the fur trade of North America might be obtained, from latitude forty-eight north to the pole, except that portion of it which the Russians have in the Pacific. To this may be added the fishing in both seas, and the markets of the four quarters of the globe. Such would be the field for commercial enterprise, and incalculable would be the produce of it, when supported by the operations of that credit and capital which Great Britain so pre-eminently possesses. Then would this country (Great Britain) begin to be remunerated for the expenses it has sustained in discovering and surveying the coast of the Pacific Ocean, which is at present left to American adventurers, who without regularity or capital, or the desire of conciliating future confidence, look altogether to the interests of the moment." He was not dreaming of steam railways reaching Vancouver from Montreal in five days, but merely of making less arduous such a journey by canoe and foot as he practically finished when having reached the Pacific he wrote : "I now mixed up some vermilion in melted grease, and inscribed in large characters, on the south-east face of the rock on which we had slept last night, this brief memorial : 'Alexander Mackenzie, from Canada, by land, the twenty-second of July, one thousand seven hundred and ninety-three.'"

Captain George Vancouver being commissioned by the King on a voyage of discovery particularly to try once more for a passage between the North Pacific and North Atlantic Oceans, spent the years from 1790 to 1795† at sea during which time he surveyed the coast of North-West America. We are, however, more concerned with the work of another explorer who spent his life between the Great Lakes and the Pacific, but who, because of the indifference of his countrymen, is less famous than Vancouver. I refer to David Thompson, Astronomer and Surveyor, as he styled himself, first to the Hudson's Bay Company, then to the North-West Company, and later acting with the International Boundary Commission, who from 1784 to 1850, as the forty volumes of records and maps made with his own hand and now in the Crown Lands Department of the Province of Ontario show, laboured strenuously for science, practically without a fellow-worker. In the published journals of Alexander Henry‡ edited by Elliott Coues, footnotes and other information from the unpublished journals of David Thompson appear, and Mr. Coues also gives us facsimiles of three sections and the title part of the great map he evidently hoped would be published. Elliott Coues says in his preface : "It has long been a matter of regret among those versed in the history and geography of the Greater North-West that this luminous record of the life work of so modest, so meritorious an explorer as Thompson was—of so scientific a surveyor and so great a discoverer—has never seen the light, either under government patronage or by private enterprise." And later in the same preface : "The irony of the event is the world's revenge on David Thompson ; but the world can never be allowed to forget the discoverer of the sources of the Columbia, the first white man who ever voyaged on the upper reaches and main upper tributaries of that mighty river, the pathfinder of more than one way across the continental divide from Saskatchewan and Athabaskan to Columbian waters, the greatest geographer of his day in British America, and the maker of what was then by far its greatest map—that 'Map of the North-West Territory of the Province of Canada. From actual surveys during the years 1792 to 1812' as the legend goes."

During the years 1819 to 1822 inclusive, Captain, afterwards Sir John Franklin, acting under a royal commission, was carrying out an "expedition from the shores of Hudson's Bay by land, to explore the northern coast of America, from the mouth of the Coppermine River to the eastward." This, and subsequent arctic expeditions, not only resulted in some important geographical discoveries, but gave to the

* "Voyages from Montreal on the River St. Lawrence, through the Continent of North America to the Frozen and Pacific Oceans." Alexander Mackenzie, London, 1801.

† "A Voyage of Discovery to the Northern Pacific Ocean," etc. Captain George Vancouver, 3 vols and atlas, London, 1798.

‡ "New Light on the Early History of the Greater North-West," etc. Edited by Elliott Coues, 3 vols, New York, 1897.

world the two most important works on the natural history of northern Canada, the *Fauna Boreali-Americana* of Dr. John Richardson, Franklin's co-explorer, and others, published 1829-1837, and the *Flora Boreali-Americana* of Sir William Hooker, 1838-1840.

In 1857, Captain John Palliser was commissioned by the Secretary of State to "conduct an expedition for exploring that portion of British North America which lies between the northern branch of the River Saskatchewan and the frontier of the United States, and between the Red River and the Rocky Mountains," with permission to go through the mountains to the Pacific. He had as associates in the expedition Dr. Hector as geologist, Lieutenant Blakiston as astronomer, and Mons. Bourgeau as botanist, who, acting under instructions from Sir Roderick Murchison and Sir William Hooker, were to be the scientific members of the party. Palliser had in 1847 and succeeding years, hunted among the Indians of our North-West and knew the country, so that during 1857, 1858 and 1859, the various routes travelled by Palliser, Blakiston and Hector, together and separately, pretty well covered the country south of the Saskatchewan from Lake Superior to the Rocky Mountains and also through many of the passes and valleys beyond. In the various blue-books* which resulted, much valuable information is put on record, and of Dr. Hector's work, Dr. G. M. Dawson, in his Boundary Commission report hereafter referred to, says: "To him the first really trustworthy general geological map of the interior portion of British North America is due; and he has besides accumulated a great mass of geological observations, the significance of many of which appears as the country is more thoroughly explored."

Captain Palliser thought it worth while to explore this country and to report elaborately upon the future prospects of civilization, but while his recommendations as to necessary steps are generally sound he certainly did not overestimate its possibilities. On the subject of confederation he writes in the report of 1860: "Much has been talked about, but perhaps less really thought of, the union of the British North American Provinces, a scheme which, although in the present age might be thought somewhat speculative, may yet not only be projected but accomplished. But it must be a work of time, and such time as many may become impatient even in contemplating." Regarding telegraphic communication he writes: "It would be ridiculous to expect for many years to come a continuous railway communication throughout this immense distance, but from the fact of over one-fourth of the distance being now complete, and considering the incalculable benefit the United Kingdom and her distant colonies would derive from connection by telegraph, I am encouraged to advocate warmly the carrying out of this enterprise."

In the same year, 1857, when Captain Palliser received instructions from the British Government, the Canadian Government commissioned George Gladman, Director, Henry Youle Hind, Geologist, W. H. E. Napier, Engineer, and S. J. Dawson, Surveyor, to "make a thorough examination of the tract of country between Lake Superior and Red River." This was done in 1857. In 1858 the Government commissioned Messrs. Hind and Dawson to extend their explorations to the country "west of Lake Winnipeg and Red River, and embraced (or nearly so) between the River Saskatchewan and Assiniboine, as far west as 'South Branch House,' on the former river." In addition to the official reports to the Canadian Government the reports appeared as British blue books and Professor Hind also published in an extended and attractive form the results of his labours in two handsome volumes.† Professor Hind, like Captain Palliser and Sir Alexander

* "Papers Relative to Exploration by Captain Palliser of that portion of British North America." etc. Canadian Blue Book, 1859.

"Further Papers," etc., in continuation of above, 1860.

"Journal," etc., in continuation of above, 1863.

"Index and Maps," etc., in continuation of above, 1865.

† "Report on the Exploration of the Country between Lake Superior and the Red River Settlement." Canadian Blue Book, 1857. British Blue Book, 1859.

"Report of the Assiniboine and Saskatchewan Expedition." Canadian Blue Book, 1859. British Blue Book, 1860.

‡ "Narrative of the Canadian Red River Exploring Expedition of 1857 and of the Assiniboine and Saskatchewan Exploring Expedition of 1858." H. Y. Hind, 2 vols., Longmans, London, 1860.

Mackenzie, indulges in prophecy. He writes: "As I stood upon the summit of the bluff looking down upon the glittering lake 800 feet below, and across the boundless plains, no living thing in view, no sound of life anywhere, I thought of the time to come when will be seen passing swiftly along the horizon the white cloud of the locomotive on its way from the Atlantic to the Pacific, and when the valley will resound with the many voices of those who have come from the busy city on the banks of the Red River to see the beautiful lakes of the Qu'Appelle." How natural it all sounds now, but doubtless it fell in 1869 upon as deaf ears as similar forecasts made at the present time by members of our geological survey, or as the fervid words of Mackenzie a hundred years ago.

I have not examined the various British blue books from 1832 to 1876, nearly forty in number, relating to the settlement of the boundary between the United States and Canada, but in addition to the work by Bigsby and Bouchette this is the time to mention two scientific results arising from marking the forty-ninth parallel. John Keast Lord who acted as Naturalist to the British North American Boundary Commission when marking the boundary line from the Pacific coast to the eastern slope of the Rocky Mountains, published two illustrated volumes in 1866 on the natural history of British Columbia.* And in 1874 and 1875, Dr. George M. Dawson, not yet connected with the Geological Survey of Canada, made his reports on the geology and resources of the "region in the vicinity of the forty-ninth parallel from the Lake of the Woods to the Rocky Mountains."†

I have thus far indicated, not with precise accuracy, but perhaps sufficiently, the extent of the exploratory work done in the country now included in Canada, under the auspices of the trading companies and the early governments, and not by established geological and natural history surveys. If we consider the publications by their number they stand as an evidence of the inability or unwillingness of Canadians in the past to grasp the future of their country, and judged by the quantity of matter of a purely scientific nature, they betray an indifference to higher considerations not creditable to their intelligence. We certainly owe a debt of gratitude to the few ardent men who braved the terrors of our unknown lands and gave us this scanty literature.

Before referring to the regular geological survey established in Canada in 1843, I should like to compare the exploratory work done in the United States before the establishment of a regular geological survey, by the Federal Government. It must be borne in mind that during nearly half a century before the Federal Government established a regular survey most of the States had established surveys on their own account just as we shall have occasion to remind you that our survey was originally a Provincial and not a Dominion survey. Not referring, then, to the work done by the various States, but merely to the exploratory work of a similarly irregular character to that done in Canada in early days, I shall read a list of expeditions ordered by the United States Government. It does not pretend to be accurate either as to the number or as to the details given of the various expeditions. It was compiled merely in order to indicate how much more earnestly the people of the United States craved for information about their unsettled areas. The majority of the reports are quartos illustrated with expensive plates and often running into several volumes. The Pacific Railroad reports alone exceed in matter all that we have done. The dates given in the following list sometimes indicate the date of the expedition, sometimes of the publication of the reports:—

1804-6. Captains Lewis and Clark. From the mouth of the Missouri River through to Pacific Ocean.

1805-7.—Lieut. Zebulon M. Pike. Through western territories of North America. To head waters of Mississippi River, through Louisiana Territory and in New Spain.

1819-20.—Major Stephen H. Long, Pittsburg to the Rocky Mountains.

1820—Henry R. Schoolcraft. From Detroit through Great Lakes to source of Mississippi River.

* "The Naturalist in Vancouver Island and British Columbia." J. K. Lord, 2 vols., Bentley, London, 1868.

† "Report on the Tertiary Lignite Formation," etc. B. N. Boundary Commission, G. M. Dawson, 1874. "Report of Geology and Resources," etc. B.N.B.C., G. M. Dawson, 1875.

1823.—Major Stephen H. Long. To the source of St. Peter's River, Lake Winnepeck, Lake of the Woods, etc.

1834.—G. W. Featherstonhaugh. Elevated country between Missouri and Red River.

1835.—G. W. Featherstonhaugh. Green Bay to Coteau de Prairie or from Missouri to St. Peter's River.

1838-42.—Wilkes, U.S. Exploring Expedition.

1839.—David Dale Owen. Geological Exploration of part of Iowa, Wisconsin and Illinois.

1842-44.—Captain J. C. Fremont, Expedition to the Rocky Mountains, Oregon and North California.

1843.—I. N. Nicollet. Basin of upper Mississippi River.

1846-50.—During these years there were seven or eight reports of minor military expeditions in connection with Texas, New Mexico and the Santa Fe route to California.

1848.—Lieut. J. W. Abert. Geographical examination of New Mexico.

1851.—Prof. L. Agassiz. Examination of Florida Reefs, Keys and Coast.

1852.—David Dale Owen. Iowa, Wisconsin and Minnesota.

1852.—Captain R. B. Marcy. Red River of Louisiana.

1853.—Captain Howard Stansbury. Valley of the Great Salt Lake of Utah.

1853-54.—Exploration and survey to ascertain the most practicable and economical route for a railroad from the Mississippi River to the Pacific Ocean. 12 volumes. Published from 1855 to 1860.

1854.—Captain L. Sitgreaves. The Zuni and Colorado Rivers.

1854.—Captain R. B. Marcy. The Brazos and Big Wichita Rivers.

1855.—David Dale Owen. Minnesota, Iowa and Wisconsin.

1855-57.—Lieut. G. K. Warren. Explorations in Nebraska and Dakota.

1857.—Lieut.-Col. W. H. Emory. United States and Mexican Boundary Survey.

1857-58.—Lieut. Joseph C. Ives. The Colorado River of the West.

1859.—Captain J. H. Simpson. Great Basin of Utah.

1859.—Captain J. N. Maccomb. Santa Fe to Grand and Green Rivers.

1859-60.—Captain W. F. Reynolds. Yellowstone and Missouri Rivers.

1871-75.—Lieut. George M. Wheeler. Exploration and Survey west of 100th Meridian. There are over thirty publications as the result of this survey.

1871-77.—Clarence King. Geological Exploration of 40th Parallel. Published in six annual reports of progress, followed by six volumes of scientific contributions by his co-workers.

Although the Federal Government of the United States down to 1867 had not established a regular geological survey and conducted the exploration of the territories by semi-military expeditions generally under control of the engineering department of the army, several of the State governments established surveys before 1835, and Sir William Logan in 1844 refers to "the liberal view of their own interests, which, during the last ten years, has induced not less than twenty of the State Legislatures of the American Union to institute investigations into the mineral resources of their respective territories," etc. I, at one time, intended to prepare a list of the various State surveys now covering almost every State, which have been conducted during the last sixty-seven years, or thereabout, indicating when each survey began and the extent of the publications, but I have found this

impossible in the short time at my disposal and I must content myself with such comparisons as will show how liberal and intelligent almost all other governments in North America have been relatively to our own.

Let us now turn to the establishment of our own regular survey.* In 1842, following the example of about twenty of the States of the American Union, the old Province of Canada instructed Sir William Logan to undertake a geological survey of the Province, work in connection with which began in 1848, Sir William having one assistant, Mr. Alexander Murray. For the ensuing ten years these two devoted men worked in the field, and after a few years Dr. T. Sterry Hunt became their able co-worker in the laboratory as chemist and mineralogist to the survey, for all practical purposes the first officer of that character, although not literally the first. No matter how devoted, two men could not do much judged by quantity, and the ten annual reports from 1848 to 1858 with two separate pamphlets on the mining regions of Lake Superior and the north shore of Lake Huron, make altogether less than 1,250 pages of small octavo, about as much matter as one annual report of the survey now. Two maps of a mine accompany one of the pamphlets, and here and there there is a badly executed illustration, but of fossils there are neither descriptions nor illustrations. It is true that in 1851 and 1852, Sir William Logan contributed important papers on the "Foot-prints in the Potsdam Sandstones of Canada" to the quarterly journal of the Geological Society in London, which were most adequately illustrated by the Society, but in these papers he thanks a member of the Geological Survey of Great Britain for naming the fossils he has occasion to refer to. If I could lay before you these twelve slender pamphlets and the still more slender reports of Dr. Gesner made in the Maritime Provinces, hereafter referred to, and put beside them the reports made by the various public surveys in the United States down to 1858, you would realize more forcibly than I can express in words how completely the Canadians failed to take that "liberal view of their own interests" which characterized the people of the United States. But somewhat better days were in store for the survey. Mr. James Richardson had been added to the workers in the field, and in 1856 Mr. E. Billings entered the survey as palæontologist. In 1857, Prof. Robert Bell, still a member of the staff, also joined the survey. The survey was now fairly equipped and its publications gave evidence of the larger scope of its operations. The report for 1858-59, published in one volume, was accompanied by the first series of maps, illustrating reports on the geology and topography of the Muskoka, Petewawa, Bonnechere, Madawaska, Maganetawan, French, Sturgeon, and Wahnapiatae Rivers and Lake Nipissing and its tributaries, also of the Island of Anticosti, altogether about 25 maps. In this volume appeared the first report of the palæontologist, the beginning of a series which established Mr. Billings' reputation throughout the scientific world. It is not accompanied by illustrations, which fate also befel some of his later reports. This is not so strange as the fact that to this day some of his species have been allowed to remain unillustrated. It is characteristic of our interest in science that his name is doubtless much better known to-day in Europe than it is in Canada. In 1863 the results of the work of the survey from the beginning appeared in the well-known volume of about 1,000 pages, published without a single plate but with about 500 good wood-engravings and an excellent atlas of maps and sections. This atlas contained the first geological map of "Canada and the Adjacent Regions," printed in colours, 125 miles to an inch, and it was followed in 1866 by the large map on the scale of twenty-five miles to an inch, coloured by hand. I wish that every Canadian might read the prefatory note accompanying this atlas, and learn what goes to the making of a reasonably accurate map of a new territory. The ordinary report of progress for the years 1863-66 containing papers by two new contributors, Mr. A. Michel and Mr. Thomas Macfarlane, was the last made to the old Province of Canada. In addition to these reports of progress, seven pamphlets appeared and six important contributions to palæontology. Four of these latter, called respectively Decades 1, 2, 3 and 4,

* "The first effort made toward the establishment of a geological survey in Canada, appears in a petition addressed to the House of Assembly of Upper Canada in 1832, by Dr. Rae. Nothing, however, came of this or of several other attempts of the same kind, till in the first united Parliament of Upper and Lower Canada in 1841, the Natural History Society of Montreal and the Historical Society of Quebec joined in urging the matter upon the government, with the result that the modest sum of £1,500 sterling was granted for the purpose of beginning such a survey." Presidential Address, R. S. C., 1894. G. M. Dawson.

appeared in 1858-59 and 1865. The contributors were Mr. Billings of the Canadian Survey, Mr. Salter of the Survey of Great Britain, and Prof. James Hall, the State Geologist of New York. They were slender octavo volumes containing altogether only 370 pages of text, but with a liberal supply of excellently engraved plates. Three of the Decades are monographs on the subject dealt with, and the four volumes are classics in North American Geology and absolutely essential to students of North American invertebrate palæontology. In 1865 the first volume, 426 pp., of a series entitled "Palæozoic Fossils" appeared, the species described being entirely by Billings. Many of the descriptions are unaccompanied by illustrations and those afforded are wood-cuts. In 1866 the pamphlet, 93 pp., entitled "Catalogues of the Silurian Fossils of the Island of Anticosti," was published. It also consists of descriptions of species, sometimes illustrated, sometimes not. This closes the work done by the survey of the old Province of Canada, the operations of which extended only to portions of what are now Quebec and Ontario. As Sir William Logan said, much of the period was occupied in obtaining topographical knowledge sufficient to enable the first geological map to be made, and indeed this is the main result of his labours.* When we look at the very small quantity of matter in the reports produced during this period of twenty-four years we must deeply regret the indifference of a people who could leave unsupported, save by two or three enthusiasts, a man with such endowments as the Director of the Survey, Sir William Logan, our honoured president in the first year of this Institute. We shall see later what this ignorance and indifference have cost us.

But narrow as was the scope of the work in old Canada it was worse in the Maritime Provinces. As early as 1838, Dr. Abraham Gesner began a geological survey of New Brunswick, which was carried on in some fashion until 1844, when it came to an end, the result being the reports detailed in the footnote below.† There was also, apparently, a report in 1843, 88 pp., not, however, styled the fifth report. Dr. Gesner had already published a volume on Nova Scotia‡ as a private venture in which he was assisted by the province, and the work in New Brunswick resulted in another contribution which reached the public in a similar manner. He was employed in 1846 by the government of Prince Edward Island to report on the geology of that province, which apparently resulted in a short report in 1847, and in 1849 he published a volume on the "Industrial Resources of Nova Scotia," but whether aided by the provincial government or not, I am unable to say. He published other papers regarding gold, iron, coal, and especially petroleum, but evidently to a languid public. In the volume on New Brunswick, published in 1847, and noted below,|| Dr. Gesner says: "Of the British North American Colonies, New Brunswick was the first to undertake an examination of her mineral resources. Since the commencement of that survey, similar ones have been instituted in Newfoundland and Canada. Prince Edward's Island has also followed the example. Nova Scotia would have engaged in such a work long ago, were not her mines and minerals sealed up by a close monopoly, which withholds from the inhabitants any participation in the mineral wealth of the country."

There were a few apparently official but irregular reports published in New Brunswick which should not be overlooked. In 1850, J. F. W. Johnston made a report on the "Agricultural Capabilities of the Province," etc., which includes geological notes by Mr. Robb. In 1864, L. W. Bailey made a report on Mines and Minerals. In 1865, Messrs. Bailey, Matthew and Hartt, made a geological report on Southern New Brunswick.

We have already mentioned Professor Henry Youle Hind in connection with the Red River and Saskatchewan expeditions. When appointed to this important

* "In 1854 . . . when before the . . . select committee of the Legislature . . . appointed to investigate the working of the survey. . . Logan was asked what the principal difficulties he had met with were; he replied: 'Independently of those unavoidably incident to travelling in canoes up shallow rivers, or on foot through the forest, are those arising from the want of a good topographical map of the country. Accurate topography is the basis of accurate geology.'" Presidential Address, R. S. C., 1894. G. M. Dawson.

† "First, Second, Third and Fourth Reports on the Geological Survey of the Province of New Brunswick." Gesner, St. John. 1st, 1839, 82 pp.; 2nd, 1840, 72 pp.; 3rd, 1841, 88 pp.; 4th, 1842, 101 pp.

‡ "Remarks on the Geology and Mineralogy of Nova Scotia; with a new map of Nova Scotia, Cape Breton, Prince Edward Island, and part of New Brunswick." Gesner, Halifax and London, 1836.

|| "New Brunswick with Notes for Emigrants." Gesner, London, 1847.

work he was the Professor of Geology of Trinity University here, and he had for many years edited the journal of this Institute. After completing the publication of the official reports and maps and the other publications which resulted from his expeditions he, in 1861, visited Labrador, the results of his exploration reaching the public in a work published as a private venture* similar in style to the London editions of the Red River and Saskatchewan Expeditions. In 1864 he was authorized to begin a new survey of New Brunswick the only result of which reached the public in the following year.†

We do not find that Nova Scotia ever attempted a geological survey. Reports generally in the shape of legislative documents on her coal and gold mines have been made by J. W. Dawson, Joseph Howe, Henry How, Henry Poole, J. Campbell, David Honeyman, Henry Youle Hind and John Rutherford, but the work in general geology has been done by men who published the results of their investigations at their own expense. In addition to the labours of Dr. Gesner in Nova Scotia we find that in 1832, Charles T. Jackson, afterwards State Geologist of Maine and Rhode Island, assisted by F. Alger, made a report on Nova Scotia‡ and Dr., now Sir J. William Dawson, in addition to a handbook in 1848, which went into at least six editions, published in 1855 the well known *Acadian Geology*|| of which there have been three editions, the third in 1878.

In 1873 Henry Alleyne Nicholson, then Professor of Natural History of the University of Toronto, aided by a small grant from the Government of Ontario, made collections of fossils in the Province, and in 1874 and 1875 published reports on the "*Paleontology of Ontario*," with several plates and other illustrations. These reports, perhaps the most valuable publications of the Government of the Province, are now so scarce as to be out of the reach of most students interested in geology, although indispensable until something more comprehensive appears. Unfortunately the descriptions and illustrations of many of the more difficult forms collected by Professor Nicholson do not appear in these reports but are published in expensive journals and other scientific works in England and Scotland, of which very few copies are to be found—in some cases literally only two or three—in all Canada. Since the excitement in mining has influenced the public, some of the provinces have established Mining Bureaus, and while these are a very inadequate substitute for regular geological and natural history surveys we owe a debt of gratitude to those who have induced unwilling governments to do even this much. The most important series of publications of this nature are those of the Ontario Bureau of Mines, which was created by legislation in 1891 and the publications of which have now reached the eighth volume. Under the guidance of its director, our worthy member Mr. Archibald Blue, it will no doubt grow year by year, limited in scope only by the liberality of the Government of Ontario. Ministers of the Crown in this province need not blind themselves to the fact, however, that since 1867, that is for thirty-two years, such material and intellectual interests in this province as would be represented by a proper survey and public museum, and which, down to Confederation, were being so excellently looked after by Sir William Logan, have been persistently neglected. The next publication regarding mines in importance is that of British Columbia. The Bureau of Mines of that province was established by legislation in 1895 and published its first bulletin in June, 1896. The annual reports for 1896 and 1897, published in 1897 and 1898, respectively, are very creditable productions, quite superior as to printing and illustrations to those of Ontario.

Now if we gather together the pre-Confederation work of Canada, New Brunswick and other provinces, and the publications by provinces since Confederation, including the Mining Bureaus, and compare the entire result with any one of say five or six of the leading States in the United States, the result must make us both astonished and ashamed. But if we add all the work done by the Dominion Survey

* "*Explorations in the Interior of the Labrador Peninsula*," etc. H. Y. Hind. 2 vols. London, 1863.

† "*Preliminary Report on the Geology of New Brunswick*." Hind. Fredericton, 1865.

‡ "*Mineralogy and Geology of the Province of Nova Scotia*." C. T. Jackson and F. Alger. Cambridge, Mass., 1832.

|| "*Acadian Geology; an Account of the Geological Structure and Mineral Resources of Nova Scotia*," etc. J. W. Dawson. Edinburgh and London, 1855.

since 1867 to the provincial work, one state, New York, exceeds the whole in quantity of matter. Pray notice that I am not discussing in any manner the respective value of the work itself. I am very anxious to impress the legislatures of the Canadian provinces as to their shortcomings, and in order to do so I shall, at the risk of wearying you, press the point still further. If one were to look over a collection of reports on geology and palæontology of the various states he could at once count between 75 and 100 quarto volumes illustrated with fine maps and literally many hundreds of plates describing many thousands of fossils and other things of course besides fossils. And then turning to octavo volumes, similar to our own, I should be afraid to say how many hundred volumes he could count, but the total result would satisfy you that I am warranted in saying that we stand disgraced until we bestir ourselves and show that we possess ordinary intelligence regarding such matters. I shall not further hurt our pride as Canadians by comparing our position with that of many South American republics whose limited civilization we are wont to deplore.

We now come to the work done by the Geological and Natural History Survey of the Dominion. Although the series of publications from 1843 to date is unbroken I have separated them in order to consider the work done by the Dominion Government apart from that of the old Province of Canada. The change which was caused by Confederation was of very great importance, although it does not seem to have impressed itself on the Canadian people. Just before Confederation we had in operation a survey of what now constitutes portions of Ontario and Quebec, which would have year by year become more minute in its character until we reached such results as those obtained in many of the States where each county is reported upon so fully that the nature of its water courses, the character of its soil, the area of its forests, the value of its minerals, building stones, clays for brick-making, etc., etc., are published in such shape as to be available to anyone interested in such matters. But instead of this very desirable consummation of the early labours of Sir William Logan his work was largely arrested by Confederation, and there was thrust upon the Survey a problem similar in character to that undertaken by him in 1843, but incomparably greater in extent, namely, the survey of an area larger than that of the United States, if we exclude Alaska. I refer to the problem as similar in kind to that undertaken in 1843, because it was destined for many years to be mainly topographical and only subordinately geological. As late as 1880 the present director of the Survey, in demonstrating the inaccuracy of our maps of the northern and western parts of the Dominion wrote as follows: * "It is very commonly supposed, even in Canada, but to a greater extent elsewhere, that all parts of the Dominion are now so well known that exploration, in the true sense of the term, may be considered as a thing of the past. This depends largely upon the fact that the maps of the country generally examined are upon a very small scale, and that upon such maps no vast areas yet remain upon which rivers, lakes, mountains, or other features are not depicted. If, however, we take the trouble to enquire more closely into this, and consult, perhaps, one of the geographers whose name may appear on the face of the map which we have examined, asking such awkward questions as may occur to us on the sources of information for this region or that, we may probably by him be referred to another and older map, and so on till we find in the end that the whole topographical fabric of large parts of all these maps rests upon information of the vaguest kind.

"Of most of the large areas marked upon the map here shown, this is absolutely true, and the interests of knowledge, with respect to these, would be better subserved if such areas were left entirely blank, or, at least, if all the geographical features drawn upon them appeared in broken lines in such a way as to show that none of them are certain. In other regions, the main geographical outlines, such as the courses of the larger rivers, are indicated approximately, with such accuracy as may be possible from accounts or itineraries derived from travellers or from officers of the Hudson Bay Company; or from the descriptions or rough sketches of Indians or other persons by whom the region has been traversed, but who have been unprovided with instruments of any kind, and whose knowledge of the country has been incidentally obtained."

* "On Some of the Larger Unexplored Regions of Canada," G. M. Dawson. *Ottawa Naturalist*. Vol. IV. 1890.

Apart from the areas of Asia and Africa not yet examined, and possibly of Brazil, the work before the Geological Survey of Canada is the greatest in extent in the world. The topographical work alone is enough to break the heart of any director supported only by the meagre grants of our Government, and if we consider the geological work, confined as it must be at first to the broadest generalizations, it is fairly certain that we shall not in another century reach the position where our people will have before them the information regarding Canada which is possessed to-day by the people of the United States regarding their country.

Our Dominion Survey, since Confederation, has published its annual reports of progress, and these have grown in size until they are among the most important annual contributions to our knowledge of geology, but they are still only reports of progress containing information largely topographical, accompanied by notes on the geological and natural history features. These reports have been accompanied by a liberal supply of maps, the majority of which are topographical and form material for the complete map of the Dominion which we may hope to see in half a century or so. In addition to the report of the director these annual reports of progress contain in separate papers the results of the labours of the various exploring parties and the reports of the section of chemistry and mineralogy and the section of mineral statistics and mines. The work of the palæontological section is published separately. These have appeared under several titles in a manner which makes it difficult to at once appreciate just how much work has been done. There are at least five distinct series, most of which are still in progress. There are the "Palæozoic Fossils" of which the first volume preceded Confederation. The first part of the second volume, containing work by Billings, appeared in 1874 and remains unfinished. Of the third volume three parts have appeared—1884, 1895 and 1897. Then we have the "Mesozoic Fossils" of which three parts of the first volume have been published—1876, 1879 and 1884. There is a series entitled "Contributions to Canadian Palæontology" of which the first volume was published in five parts and is complete—1885, 1889, 1891, 1892 and 1898. The present able palæontologist, Mr. J. F. Whiteaves, Assistant Director of the Survey, succeeded Mr. Billings and these volumes contain his work alone. The first part of the second volume of "Contributions to Canadian Palæontology," which appeared in 1895, is devoted to Canadian Fossil Insects and is by the eminent authority on that subject, Dr. S. H. Scudder, of Cambridge, Mass. The first part of the third volume, published in 1891, is the only quarto publication. It is by the late E. D. Cope and is a valuable but all too small contribution to our knowledge of the fossil vertebrates of the North-West. We have also a series called "Contributions to Canadian Micro-Palæontology," of which have been published four slender parts of a first volume by as many authors, none of whom are members of the Survey, but all experts in the particular subject. In addition to these series Sir William Dawson contributed two monographs on fossil plants, published in 1871, 1873 and 1882. This sounds like a great deal of matter but when put together there are less than 1,500 pages and about 185 plates, equal in quantity to two, or at the most three, average reports in the United States. This is what we have produced in thirty years from a country most notably rich in fossils, and during a period when hundreds of volumes on palæontology have appeared in the United States. In botany there have been six extensive catalogues of Canadian plants and several additional pamphlets mainly the work of the indefatigable botanist of the Survey, Mr. J. Macoun. I do not remember a single illustration, although in the United States Pacific Railway reports already referred to, there are hundreds of engraved plates illustrating western plants. There are a few other publications of the Survey and many contributions by members of the Survey to the volumes of the Royal Society of Canada and to other journals, but they only serve to emphasize the impossibility of making bricks without straw. I am very happy to hear that in addition to the contributions of Mr. Whiteaves we are to have important contributions in the shape of a revision of the Palæozoic Corals of Canada by Mr. L. M. Lambe of the Survey and I hope we may soon see the results of Dr. H. M. Ami's work in print and plates. It is also gratifying to hear that Dr. G. F. Matthew, of St. John, N.B., one of the most eminent authorities in Cambrian geology and whose contributions to the Royal Society of Canada form the most important additions to our knowledge of this branch of palæontology, is to do work

in certain fields for the Survey as he did some years ago. If we could but feel that as the field workers bring in material it would be studied at an early date by the palaeontologists of the Survey, so far as it might come in the line of their studies, and that the rest of the material would be submitted to other palaeontologists, who are experts in the particular subjects, a new day would dawn for us, but without money this is impossible. I have not alluded to the particular explorations of those who worked in the field under the directorship of Dr. Selwyn and of his successor, Dr. Dawson, and of their fellow-workers in the laboratory and study. It would be impossible to mention the names of all or to make a selection, but we can well afford to thank the few who are left in the field, Messrs. McConnell, Bell, Ellis, Fletcher, Low, Macoun, and others, for their devotion.

In 1867, the year in which the Dominion Government took charge of our survey, the United States inaugurated the first regular survey under the Department of the Interior. It was called the "Geological and Geographical Survey of the Territories," and was under the charge of Dr. F. V. Hayden, until it was superseded in 1880 by what is called the "United States Geological Survey." A comparison of the publications of these two surveys alone with those of Canada during the same period, would be unfair to the United States, because we thus overlook the publications of the Smithsonian Institution, the United States National Museum, and other departments at Washington, but the result is overwhelming enough. We must also bear steadily in mind the fact that while these publications were being produced, twenty-five or thirty States were also actively at work, while the Provinces of Canada were doing practically nothing. During Hayden's Survey, 1867-1879, annual reports were issued somewhat similar to ours in size and character, but there were also five volumes of bulletins, containing upwards of 150 papers, thirteen miscellaneous, and fifteen unclassified publications, about seventy-five maps, and thirteen final reports or monographs. The monographs were splendid quartos, liberally supplied with plates and other illustrations, and illustrating and describing vertebrate and invertebrate fossils, including fossil insects, also fossil flora, and existing forms of rodents, acridians, rhizopods, etc., all from the far West. The present survey has published nineteen annual reports. The last report will include, apparently, six parts, and some of the parts cover two volumes. I wish it were possible to explain here the scope of this one annual report. Of bulletins about 150 had been published down to 1897, and of papers on water supply and irrigation, ten. Of monographs, of the same character as those under Hayden's Survey, thirty-four. Of maps, statistical papers, etc., there has been also a liberal supply.

The operations of our Survey for the year ending June 30th, 1897, cost \$117,000. For the nearest year in the United States the cost was \$1,034,000. Our usual basis of comparison is population, and measured thus we spend the most, but clearly, that is not the measure for this particular item of national expense. The real basis of comparison between the United States and Canada of expenditure for survey and topographic purposes, should be the respective areas of unexplored or insufficiently explored territory. Judged thus, Canada should be spending much more than the United States, and we must not forget that in comparing the \$117,000 spent by Canada with the \$1,034,000 spent by the Federal Government of the United States, we leave out the large expenditure by the various States carrying on surveys on their own account. I am quite sure that on mere topographic work we should spend more than the United States, but I am aware that we think at all events that we cannot afford to spend so much, and I would not spoil a good cause by asking for what will certainly not be granted. But looking at matters in the hard light of politics, and gauging the possibilities in Canada by other countries not more able to spend, I am quite sure that at least \$250,000 annually should be appropriated for our geological and natural history survey. And in addition to this, the Provinces should each spend at least \$10,000 annually and carry on their work in concert with the Dominion Survey, so that in all respects there would be united effort and no unnecessary duplication of work. Perhaps some of the Maritime Provinces would think \$10,000 too high, and a smaller sum might suffice, but for Quebec, Ontario and British Columbia with their vast areas, the sum suggested is very small. That the people would find the expenditure a good investment in dollars and cents I am certain, quite as good an

investment as our expenditure on canals and railroads. I approve of state aid to railroads and canals in a new country, because transportation is one of our greatest problems, but the first duty, the very first duty of an intelligent country, is to know what it has or may have to transport.

In conclusion I should like to say a few words as to what we might reasonably expect in the way of Dominion and Provincial surveys. We should have the Dominion and Provincial surveys working out the topography in a far more minute manner and on a greatly larger scale than at present. We should never again send out a topographic party, a boundary party or a land surveyor laying out a base line, without being accompanied by trained geologists and naturalists. The history of our own Northern Ontario is an example of what we have failed to accomplish in this respect. We should not only publish annually such broad truths of geology and natural history as are gathered during these rapid topographic surveys, but we should be engaged in our provincial surveys on reports dealing with the features of each county separately, and in our Dominion Survey in working out special problems of geologic or other scientific interest. For instance, in the United States there are many complete monographs dealing with the iron ores of different localities, or the coal, or natural gas, or the forestry conditions, or other problems of great commercial importance. Have we no curiosity about our great areas of iron ore, our really wonderful coal fields, and our other minerals? Should we not appreciate intelligent monographs on the treatment of refractory ores, on modern mining machinery, on brick-making, salt-wells, gas-wells, and the many other things so intelligently presented to the people by the State in more favoured countries? Of course we should. Let our Governments but try.

And as to Public Museums. The Dominion Government at Ottawa and each province, at its city of chief importance, should have a museum belonging to and supported by the people. These museums should contain exhibits of the metallic and non-metallic minerals of the country, both those of economic and of merely scientific value, the forest trees, with the bark preserved, in say six feet sections, cut also and partly polished, and each specimen accompanied by a small map showing its habitat; the fresh water and sea fishes, mounted after the modern methods; the fur-bearing animals, the game birds, and the birds of our forests, fields and sea-coast, many of them mounted so as to tell a child their habits at a glance; the reptiles, crustaceans, insects, plants, indeed as complete a record of the fauna and flora of the country as possible; the rocks of stratigraphic importance and all the varieties of fossils which can be gathered in this country; the archaeological and ethnological evidences of the races we have supplanted in Canada, and much more that does not occur to me at the moment. I should not like to suggest a limit of expenditure on such museums. The necessity of a new building at Ottawa is admitted. The crime of leaving exposed to fire, in a wretched building never intended to protect anything of value, the precious results of over fifty years of collecting, has been pointed out in a recent official report. But the Government seem deaf to such claims. I can only repeat that we are rich enough to bear the cost with ease, but we are not intelligent enough to see our own interest in spending the money.

I have been careful to indicate that so far as this is an account of what has been done in geology and natural history in Canada, it is mainly a record of work done officially, that is for the governing bodies and not by individuals unassisted by public money. But it must not be supposed that I am unmindful of the fund of information which has reached the public through the journals of the scientific societies of Canada, some of which have been labouring for over half a century in this field of higher education. Nor must I fail to acknowledge that such societies are, as a rule, aided by public grants of money. It would have been a great pleasure to have mentioned many of the writers and investigators who have contributed gratuitously in the past to this fund of knowledge, but I can do no more than to record here our gratitude to some of the living geologists—to Sir J. William Dawson, Dr. G. F. Matthew, Prof. L. W. Bailey, Dr. J. W. Spencer, Dr. F. D. Adams, Prof. A. P. Coleman, Mgr. J. C. K. Lafamme, and all others who still labour in the good cause, although not members of our Survey. I am aware that I should add the names of many botanists, ornithologists, entomologists and other

workers in natural history, but I fear my knowledge of these subjects is too limited to enable me to give credit where it is due.

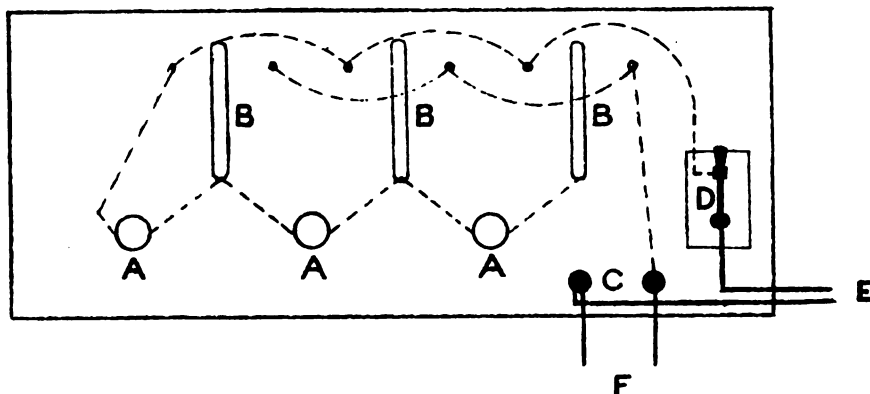
I am sure I must have wearied you with such a lengthy address. I have but one excuse—my firm belief that the future of Canada depends to a degree not generally recognized, upon our liberality in spending money to exploit our country.

A CONVENIENT RESISTANCE FOR ELECTROLYTIC ANALYSIS. BY J. WATSON BAIN, B.A. Sc.

(Read 10th February, 1900.)

CHEMISTS, who employ electrolytic methods, are often annoyed by difficulties in obtaining a suitable current. Primary batteries are most unsatisfactory in many ways, requiring constant attention, and being subject to considerable variation in their current. Storage cells are very much more convenient, but the necessity of charging is a drawback, and detracts somewhat from their value.

By means of a suitable resistance, the direct current of the ordinary incandescent circuit may be used with great comfort; the variations which occur



are so slight as to be negligible, there are no cells to be kept in order, and the current is always ready for use. A convenient resistance for this purpose has been employed in the chemical laboratory of the School of Practical Science for more than a year, and a brief description of the apparatus, may be of value to those, who have not had time to experiment for themselves.

The arrangement is represented in the accompanying diagram in which *AAA* represent three sixteen-candle power incandescent lamps, with their sockets; *D* is a single throw switch; at *C* are two binding posts, to which are connected the wires *F* leading to electrodes in the solution under analysis;

BBB are strips of brass, pivoted at the lower end, each of which can make contact with two of the studs, represented by heavy dots in the diagram; *E* are feed wires from the incandescent circuit; and the dotted lines represent the invisible connections.

These various parts may be conveniently mounted on a board eighteen by eight inches.

By combining the lamps in different ways, currents varying from 0.2 to 2 amperes may be obtained, a range which is ample for the usual electrolytical work.

NOTES ON SKULLS TAKEN FROM A PRE-HISTORIC FORT IN KENT COUNTY.

BY MR. ARCHIBALD BLUE.

(Read 21st April, 1900.)

THE Indian Fort on lot 59 north of Talbot Road, in the Township of Orford, is situated at the springs which are the source of Clear Creek, two-and-a-half miles from the shore of Lake Erie and a mile from the decayed hamlet of Clearville. Until twenty years ago the Fort stood in the midst of a dense forest of beech and maple, white oak and black walnut, and there were trees of large size growing on the walls and within the enclosure. The site was known to the early settlers, but none among them were archæologically inclined, and the ground was not disturbed by them. It used to be said, however, and I think it is true, that one of my old schoolmasters, Galbraith the Phrenologist, was a frequent visitor there, and that he dug up some skulls to help in his studies. It was while he was employed as teacher in our school, in the years 1848-49-50, that he applied his spare hours to acquiring a knowledge of Phrenology, and from our school he went out on his long career of lecturer on the subject in this Province and elsewhere.

But the first serious attempt to explore the Fort was made eleven years ago by Mr. David Boyle, our archæologist, who succeeded in getting six skulls which are now in the Museum of the Education Department. Mr. Boyle made measurements of the Fort, and a sketch and description of it together with an account of his exploration was printed in the Proceedings of this Institute for 1888-89.* In Mr. Boyle's opinion the graves exhumed by him did not probably belong to the people who built the walls, but to subsequent possessors of the ground who had lost all knowledge of its former occupancy.† He suspects, indeed, that there were three successive occupations by different tribes separated by wide periods of time. The skulls secured by him were discovered in an ossuary on the highest plane within the walls, and had been interred with the limb bones only.

These Notes lend confirmation to Mr. Boyle's views, and being mainly a transcription of the entry in my notebook made upon the ground I can vouch for their accuracy.

It was on the 14th of August, 1889, about a month after the explorations made by Mr. Boyle, that I first saw the Fort, although I had known of it from childhood. I was accompanied by Dr. P. H. Bryce of this city and my brother, the late John Blue, jr., of Orford. The trees had been cut down and the timber removed at that time, but most of the stumps were yet fresh and showed that a number of the trees were of large size. In all other respects the site was practically unchanged. The walls or embankments of the Fort were in an excellent state of preservation, and oblong or nearly oval in form. As originally constructed they appear to have followed upon the north, west and south sides the edge of the bank of the creek and one of its small tributaries, and there are cross-walls from north to south which divide the enclosure into three unequal areas, two of which occupy benches of the creek, while the third is on the tableland of the country. Where intact, the walls are about ten feet wide at the base, three to four feet high, and about five hundred yards in the outer circumference. At the north-east angle there is a breach in the wall about twenty-five feet long, which may have been an opening to the midden-heap, and at the north-west angle is a low bit of wall about seventy-five feet long. There is a third opening midway in the

* Annual Report of the Can. Inst., Session 1888-9, pp. 15-18.

† Notes on Primitive Man in Ontario, 1895, p. 20.

west wall, which no doubt was the water-gate of the Fort, as some of the springs which feed the creek are not more than thirty feet distant from it. The north wall like the west one extends parallel with the ravine, but is at a higher level and overlooks a steeper slope. As already stated, the enclosure occupies three distinct levels, separated by cross walls, the lowest one on the first bench of small extent, and the upper ones which rise by successive steps embrace about 7,000 square yards each.

Numerous openings had recently been made on the upper level and also upon the enclosing walls, at almost every one of which we found ashes, bones and pieces of pottery. Along the northern side of the second bench we were attracted by a small but distinct depression, about six feet in width and lying 5° west of north. As it seemed to be a likely spot for exploration we made an opening along the middle of it, at a point twenty-five feet from the base of the north wall. At a depth of eighteen inches the spade struck and broke what proved to be a thigh bone, and the limb was carefully uncovered down to the foot. We then opened towards the head, measuring about six feet from the heel, and struck upon a skull in such a position as led us to suppose it must be part of the same skeleton as that of the thigh and leg bones already uncovered. Extending the work from the head downward we found the position to be such as would suggest that the pelvis had been bent from the general line of the body; but further digging showed that we were upon a second skeleton, lying upon the east side of the first. Having removed the earth from a space seven feet long by four wide, the true situation was apparent. The bodies had been laid side by side on a north and south line, but with the heads inclining towards each other at an angle of about 15° .

The bones had the usual yellowish brown color peculiar to extremely old bones, and were so fragile as to crumble almost at a touch. The sutures however indicated that the age of the persons at the time of death would not exceed 40 years.

The skeleton lying upon the right or westerly side was obviously that of a male person, as it measured five feet nine inches in length and was relatively narrow across the pelvis region. It was equally obvious that the other was a female, the length of which was five feet five inches with a relatively broad pelvis. The head of the male was thrown forward, with the lower jaw fallen down upon the vertebrae of the neck, the cause of which was discovered in the root of a walnut tree which had entered at the right ear, and, passing through to the left side, pushed the sub-maxillary bone out of position. The skull may be described as rather brachycephalic, but with retreating frontal bones, broad occiput and dome-shaped vertex. It was completely filled with a fine black mould, upon removal of which the parts separated and fell to pieces. A curious find in the base of the skull was the under-jaw of a chipmunk. There were twelve teeth in the lower jaw of this skull, well preserved, but the two left incisors were blackened and worn down about one-twelfth of an inch below the level of the other teeth. The two bicuspid teeth on each side were missing, but the molars were sound. The bones of the vertebrae and all the lower parts of the body were in position. Those of the feet were lying outwards. The bones of the left side were throughout more fragile than those of the right, except in the skull, which was injured by the root that had penetrated it. The arms lay alongside the body, extending two-thirds of the way down the thigh bones, but with the fingers of the right hand underlying the thigh.

The female skeleton was in a better state of preservation than the male, except as they were injured by the root, which, extending under the skull and spinal column, had destroyed the occipital bone and portions of the spine. The head was very nearly within the brachycephalic limit, with high and rather broad frontal bone, wide occiput and large eye sockets. The teeth were in good condition, and only three were missing—two bicuspid in the lower and one in the upper jaw. The front lower teeth were slightly worn.

There is no doubt from the color and condition of these skeletons that they had lain a long time in the earth; but additional evidence of time is afforded by the root which had disturbed them. This root, which was two-and-a-half

inches in diameter, belonged to a walnut tree which grew within the walls of the Fort, at a distance of fifteen feet to the north-west of the bodies. From the appearance of the stump, the tree had been cut down for at least a quarter of a century. The diameter across the cut was forty-six inches, and I counted four hundred and eighty concentric circles of growth, exclusive of two inches of decayed wood on the circumference. Assuming each circle to represent a year, the beginnings of that tree must be carried back to the dawn of the fifteenth century, or nearly a hundred years before Columbus discovered America, and the probability is that during the first period of occupation no trees stood within the walls of the Fort.

The skulls exhumed by Mr. Boyle were found in the highest plane of the enclosure, where evidently they had been re-interred. All of them are remarkably fresh and well preserved, as compared with those taken up by Dr. Bryce and myself; but one is minus a portion of the left temporal bone, so that an exact measure of its breadth cannot be secured. Measurements of the two lots for calculating the cephalic indices have been made for me by Mr. Boyle, and they are interesting in so far as they appear to prove that the older and newer skulls represent two distinct races of people who at different times occupied the same locality. The skulls collected by Mr. Boyle are given according to their catalogue numbers and with brief descriptive notes.

No. 12,480.— $6\frac{1}{2}$ by $5\frac{3}{8}$ inch. Nicely formed skull of a woman. Reddish brown in color, as if caused by suffusion of blood. No Wormian bones. Age, 35 to 40 years. Cranial index, $79\frac{1}{2}$.

No. 12,494.— $7\frac{1}{2}$ by $5\frac{1}{8}$ inch. Pronounced supra-orbital development. A strongly formed skull, with sutures prominent. Age, about 50 years. Cranial index, $68\frac{1}{2}$.

No. 12,499.— $7\frac{1}{2}$ by $5\frac{1}{2}$ inch. Occipital bone largely developed, with very prominent process. Large Wormian bone at the fontanelles of the parietal and frontal bones and along the occipital suture. Age, 60 to 65 years. Cranial index, 76.

No. 12,500.— $7\frac{3}{8}$ by $5\frac{1}{2}$ inches. Extraordinary development of supra-orbital ridges. Sutures ossified. Age, probably 80 years. Cranial index 71.

No. 12,501.— $7\frac{3}{8}$ by $5\frac{1}{8}$ inch. Skull of very fine texture. Slightly unsymmetrical in occipital bone. A few Wormian bones around the occipital. Age, 40 to 45 years. Cranial index, $74\frac{1}{2}$.

The two old and uncatalogued skulls give the following measurements :—

Male.—7 by $5\frac{1}{2}$ inch. Cranial index, $78\frac{1}{2}$.

Female.— $6\frac{3}{4}$ by $5\frac{1}{2}$ inch. Cranial index, $77\frac{1}{2}$.

The cephalic index is used to represent the percentage of breadth to length in the living head, and is assumed by Ripley and others to be two to three per cent. more than the cranial index or proportion according to skull measurement. When the percentage rises above 80, according to Ripley, the head is brachycephalic; when it falls below 75, it is dolichocephalic; and when the index is between 75 and 80 it is mesocephalic,—or short, long and medium formed heads respectively. Applying this rule to the skulls of the Clear Creek Fort, it is found that the two old skulls are on the border line of the brachycephalic class. Only one of the later skulls belongs to that class, two are markedly dolichocephalic, and two are mesocephalic.

There are not a sufficient number of skulls for computing an average index. As far as numbers go, however, they indicate that two widely different races are represented, and so completely are they cut off from us that even the more modern of them has hardly left an event, a record, a fact, or a tradition out of which to weave a page of human history.

THE PRESIDENT'S ADDRESS. BY JAMES BAIN, JR., ESQ.

(Read 18th November, 1900.)

IN declaring open the fifty-second session of the Canadian Institute, my first duty is to thank you for the honour you have conferred by electing me to fill a chair which has for half a century, been occupied by a succession of eminent men, the very recollection of whose names fill me with a sense of my own unworthiness. The recent semi-centennial celebration forcibly reminds us that the old generation has almost passed away and that a new generation has entered into its place, let us hope, with the same simple, earnest, unselfish desire to advance the cause of scientific research in this city and province, and to enrich ourselves with a deeper insight into the secret processes of nature. In addressing you on this occasion, it seems natural that I should consider the Institute and the work which is being carried on in it, from the standpoint of my own profession, and its library, therefore, occupies a leading position in my remarks this evening.

Private libraries, when accumulated by thoughtful men are almost always the reflex of the owner's mental pursuits, whether he gathered his books as his working tools, or indulged in what is generally called literature, for the refreshing of his mind and indulgence of his love for the beautiful. Associations of persons engaged in search for common objects or desiring a common end, must, if they accumulate books, follow the same course as private individuals, and their library becomes the reflex of their wants. The collection is more or less heterogeneous according to the number of those who have influenced the purchasing. In this way, libraries such as our own have grown up, and while special libraries for scientific use have often been collected in a brief space of time, and with a strict adherence to the definite purpose for which they were intended, most collections made by young and energetic societies have grown, as I have described. When the Natural History Museum was removed from the British Museum to South Kensington, it was resolved, to buy new working libraries for each department, rather than deplete the collection in Bloomsbury. A large sum of money was granted for this purpose to the Botanical Department, and perseverance and energy extended over a few years, created a library of books on this branch of Science, which has few equals. It is seldom however, that libraries are thus formed. During the early years of this Institute, it was the intention of the members to obtain either by purchase or donation, those books on science, history, travel or biography, which, month by month as they were published, commended themselves to the council, as being of more than ephemeral value. In looking over the remains of the early purchases, it is interesting to trace the individual tastes of the members of council of those years. The removal of the Institute twice, the change in the manner of life, carrying the homes of the members further from the centre of the city, and most important of all, want of funds, tended to diminish interest in the Society's collection of modern scientific literature. A library of current books, whether scientific or not, depends for its active existence upon a steady influx of new books, and when this ceases, the library rapidly loses its position and usefulness.

During this period however, a continuous stream of transactions, collections, proceedings, archives and other publications of learned and scientific societies poured in, so that when the present building was being completed, the council realized for the first time, that they had the nucleus of a library which might become extremely valuable from its wealth of scientific material. For some years the council devoted a considerable portion of its limited income to binding the accumulations, but finding that they were not able to overtake the arrears and keep up to the yearly additions, they asked the government of the Province to aid them in what they felt was a provincial work. This

assistance was generously and readily given for two years. A surplus in the hands of the committee for the reception of the British Association in 1897, was also handed over to the Institute, for the purpose of increasing the number and completing such sets as it was desirable either to buy or perfect. This work is now being carried on by your library committee, a number of sets have been completed during the past year, and an accurate list has been made of the balance, to obtain which persistent efforts will be made. Most of the miscellaneous books have been exchanged or sold, and all the available space devoted to the publications of Societies. The library of the Institute is therefore strictly specialized as a Science library, not limited to any one branch of Science. It contains to-day about 7,000 bound volumes, containing the annual or biennial publications of 588 societies. These societies are scattered over the civilized world, wherever men are thinking and working on scientific lines. The mere list of countries is suggestive, as I go over them in alphabetical order: Algeria, Argentine Republic, Austria-Hungary, Belgium, Brazil, British Guiana, Canada, Chili, China, Cape Colony, Costa Rica, Cochin-China, Denmark, Ecuador, Egypt, England, France, Germany, Greece, Holland, India, Ireland, Italy, Japan, Java, Mexico, New South Wales, New Zealand, Norway, Peru, Portugal, Queensland, Roumania, Russia, Scotland, Spain, Straits Settlement, Sweden, South Australia, Switzerland, Tasmania, Tunis, Turkey, United States, Uruguay, Victoria, West Indies, forty-seven in all. Some of the countries have so recently entered the field of Science, that it is difficult to realize the change which has taken place in a hundred years. That Algeria or Cochin-China, or Java, or Costa Rica should be there, is one of the features of the 19th century, which marks it off from all preceding eras. Down nearly to the middle of the 18th century, Latin was the common language of Science in Europe, and the use of a common tongue did much to extend scientific knowledge, at a time when the number of students in each country was limited. But now the vulgar tongue prevails within certain limits, for we find that though these five hundred and eighty-eight sets represent forty-seven countries, they only require fourteen languages. English has 281, French 100, German 89, Italian 42, Spanish 34, Norwegian 9, Swedish 8, Dutch 8, Russian 5, Hungarian 4, Danish 3, Portuguese 2, Latin 2, Modern Greek 1. As might be expected their subject matter is extremely varied. A large number of societies like our own, include within their publications, original papers on any subject of scientific research. The number of sets published by these general societies is two hundred and eighteen, and the remaining three hundred and seventy are divided thus:—Chemistry 5, Botany 14, Geology 29, Archæology 25, Engineering 39, Philosophy 25, Geography 40, Philology 7, Entomology 6, Astronomy 11, Biology 6, Physics and Mathematics 12, Zoology 4, History 28, Meteorology 13, Ethnology and Anthropology 38, Agriculture 9, Medicine 8, Statistics 10, Law 8, Mineralogy 1, Microscopy 7, University Papers 21.

The yearly increase is about two hundred and fifty volumes. The number of papers or treatises in each volume may be estimated at an average of ten, which fairly represents 70,000 separate books.

Let us now compare our situation with that which prevails in older countries. In all these it may safely be said that they point to the number and quality of their libraries, and the use that is made of them as one of the evidences of their culture and intelligence. The nation without such marks of learning, is lower in rank in the scale of civilized peoples, and one of the distinguishing marks of its rise, is the number of libraries which are established. Outstanding above all others in English speaking countries, is that of the British Museum with its 2,000,000 printed books and manuscripts, and 200,000 pamphlets, with its readers from all parts of the world, and its yearly increase by purchase, donation and copyright of 27,000 volumes, and 67,000 serials and parts of books. In English books it is the richest in the world, and in the literature of France, Italy, Russia, Germany and Austria it is only second, if indeed second to the National Libraries of these countries. Its collection of American books is equal to anything on this side of the Atlantic, and its Oriental literature is not rivalled by any of the great cities of the East. The United Kingdom also possesses in addition over three hundred libraries, ranging from five thousand

to half a million volumes. The largest library in the world is that at Paris, which contains about two and a quarter million of books and 160,000 manuscripts, and France possesses in addition five hundred public libraries, containing four and three-quarter million of books. Germany has no less than ninety-seven large libraries, averaging 100,000 volumes each, the Royal Library at Munich, having something over 900,000 volumes, and the Royal library at Berlin over 700,000. We are not accustomed to think of libraries in connection with Austria-Hungary, but it stands first among all the countries of Europe for numbers, having no less than five hundred and seventy-seven public libraries, containing about 6,000,000 volumes, a number which is equal to about twenty-six books per head for the entire population. Russia, so comparatively recent in its civilization, has one library very nearly as large as the British Museum, and seven over 100,000 volumes. Even the smaller countries, like Switzerland and Denmark, have respectively eighteen libraries, ranging from 40,000 to 100,000 volumes, and four libraries containing 725,000 volumes. I might continue the list of countries, which all tell the same story, but will only mention one other,—the little Island of Iceland, poor in men and means, but exhibiting to us its love of learning, has one scientific library of 30,000 volumes in addition to several libraries of general literature. I have purposely refrained from mentioning the American libraries, because so many of them are familiar to us, and because most of us are astonished at the wealth which has been expended upon them, the rapidity of their growth and the energy with which they are conducted. But it may well be said that these are general libraries, which by the assistance of the State, or by private generosity are enabled to make immense collections for the benefit of readers of all classes. As general libraries they strive to cover the whole field of human knowledge, and do so more or less superficially. Even in the case of the British Museum, we were recently told by a very high authority, that "it did not contain more than one-half, or at least three-fifths, of the books in English which have been printed." It is not too much to say that the best library of the English speaking people, is more or less, of a makeshift. Mr. Bullen, the late keeper of the printed books in that library recognized this, when he testified before the Society of Arts, "that on few or no subjects to be investigated, could the British Museum afford the scholar half the necessary books." Let us now turn to the consideration of societies like our own and see what they have done to supply the demands of their readers. In Great Britain the Royal Society has 75,000 volumes, the Royal Institution has 50,000, the Royal Irish Academy 80,000, the Newcastle Literary Philosophical Institute 60,000, and many others with corresponding numbers of books in their libraries. But these while confining them to Science generally, evidently do not meet the wants of students in special subjects, for we find a Geological Society's library of 17,500 volumes and another of 30,000, a Geographical of 25,000, a Statistical of 27,000, and an Electrical Engineers of 100,000 volumes, and so on through every branch of the Arts and Sciences. Now think of these and then of our collection of two hundred and ninety volumes in Geology, or in Geography of four hundred, or Statistics of one hundred volumes.

The fact is, that when a student enters upon a special branch of study, he finds so little to help either in our own library or in other libraries in this city, that he is compelled to look elsewhere for the literature of his subject. Let him be engaged upon, say, botanical research, he would find that our apparently large collection contains perhaps one hundred and fifty volumes devoted to this subject, and so with every other branch of Science. The closer the student specializes, the more difficult it is for him to arrive at what is known, as a basis upon which to carry on his researches. It is evident that our library, however complacently we may admire it, is as yet, but in its infancy. We must not cease to enlarge and develop it, every opportunity must be taken to increase the number and preserve the high character of its books. The council has done wisely in fixing the limits within which it ought to grow. Other institutions in this city have their own place to fill, and should be stimulated by our example, to increase their usefulness within their own limits. We must do more to meet the wants of our own students, gaining from them such a knowledge of our shortcomings, as will aid us in building up our collection

on special subjects. The student who knows his subject is the best friend of the library, and the council would act wisely in purchasing freely, to meet his requirement, even if for a year or two, the library may become one-sided. Others follow in time on different subjects and should be treated in the same way, so that the period is not far distant, when it would become a scientific library of high standing. It is well to remember that a library is not of value according to the number of its books, but because of their character and the facility with which their contents may be known. The Eucyclopedia represents the demand for systematically arranged knowledge. The information contained in it may be found in more extensive form, in more interesting shape and in close connection with its context, in a few hundred books, but the ordinary reader has no time to make the necessary search, or lacks the necessary knowledge to guide him, and therefore turns to a quarter where it is found under its proper letter of the alphabet. It is therefore better to have a library of 5,000 volumes fairly covering two or three subjects and provided with the proper apparatus for gaining a knowledge of its contents, than 20,000 which are scattered over all subjects, without such a guide. The one will attract special students from all directions, who will find within reach, their subject fairly treated, while the other will become the happy hunting ground of the dillitante, or the careless, edifying none. To make our own library worthy of the Institute, it is essential therefore, that it should increase in fixed directions, that subjects should be chosen which can be worked up, and that proceeding thus, department after department might be made so complete, as to make it of immense value to the whole Province. One of the requirements which I have pointed out as an essential in a good library, is an easy and accurate means of obtaining a knowledge of what it contains. In our case this is rendered even more necessary, as the treatises we have and hope to obtain, are contained in volumes which bear as their title the name of the society by whom they were issued. In some cases the contents are very miscellaneous ranging over many subjects. Some institutions publish at long intervals, ranging from ten to fifty years, properly arranged catalogues or indices, covering the volumes published during the interval, but the index may be only for the early volumes, while the information sought is to be found in the more recent. The expense of preparing a catalogue, month by month, as the different fasciculi arrive, is so great, that no society with limited sources of income could undertake it. Fortunately for small libraries and scientific enquiries, this difficulty is now being overcome, and what one society could not hope to do, the many in combination are about to do. About ten years ago, a conference under the auspices of the Royal Society, was held in London, to consider the possibility of a co-operative catalogue of scientific papers. The conference contained representatives from almost all civilized countries, and was favourable to the undertaking. Much time and infinite pains have been taken to arrive at a basis upon which to proceed with the work, and at the meeting held in London in June last, the conditions as amended and reconsidered, were finally adopted unanimously. The objects and nature of the catalogue are thus defined:—

1. That it is desirable to complete and publish by means of some international organization, a complete catalogue of scientific literature arranged according both to subject-matter and to author's names.

2. That in preparing such a catalogue, regard shall, in the first instance, be had to the requirements of scientific investigators, to the end that these may, by means of the catalogue, find out most easily what has been published concerning any particular subject of inquiry.

3. That in indexing according to subject-matter, regard shall be had, not only to the title (of a book or paper), but also to the nature of its contents.

4. That the catalogue shall comprise all published original contributions to the branches of science hereinafter mentioned, whether appearing in periodicals, or in the publications of societies, or as independent pamphlets, memoirs or books.

5. That a contribution to science for the purposes of the catalogue, be considered to mean, a contribution to the mathematical, physical or natural sciences, such as, for example, mathematics, astronomy, physics, chemistry.

mineralogy, geology, botany, mathematical and physical geography, zoology, anatomy, physiology, general and experimental pathology, experimental psychology, and anthropology, to the exclusion of what are sometimes called the applied sciences.

The convention conferred power upon an International Council to carry out the details of the work on the lines laid down, during each ten years' interval of the meeting of the convention. The central Bureau for the actual work, is located in London, and Regional Bureaus "have been established in all countries, who will be responsible for the preparation of the slips requisite for indexing all the scientific literature of the region, whatever may be the language in which that literature may appear." The Regional Bureau also sends one member each to the International Council. The catalogue is to be issued for the present, in book form only, at least one annual volume for each science, the first group to be published in July 1901, and continued regularly at quarterly intervals. Each annual volume will contain an author's and subject catalogue, and the first literature to be included in the catalogue, is that of January, 1901. This enormous undertaking, which has been carried out under the inspiration of the Royal Society, will prove of infinite value to scientific labourers, and to the library it not only means perfection of cataloguing of the books it possesses, but an absolute guide to what it has not and what it requires.

At the first conference held in London, in 1890, invitations to send delegates, were extended to all countries. Canada was represented on that occasion by Lord Strathcona, who freely expressed the good wishes of the Canadian Government. At the last conference, it was resolved to ask all the countries represented at any of the conferences, to assume a certain amount of financial responsibility. A sum was to be agreed upon as the approximate yearly cost of each year's volumes, until some years of experience permitted more accurate calculations. Each country was asked to guarantee a fixed number of sets for five years. The United States for example were apportioned forty-five sets and have already subscribed fifty-eight. Canada as yet has done nothing, and is now asked to bear her share. Our national honour demands that she should not hold back from this work of the community of nations. I trust that this Institute will not be backward in its efforts to induce the Government of Canada, to do, what is being done by other colonies of the Empire, and by Denmark, and the smaller countries of Europe, and that at least a sufficient number of copies shall be subscribed for, to supply the eight or nine Universities of the Dominion.

A successful library on the lines I have indicated, would create such a standard as would naturally influence the other libraries of the Province. The demand for a Provincial Central Library, commensurate with the importance of its interests would follow in due course. The Economic Arts would demand the same attention, the Fine Arts in the various forms of painting, sculpture and decorative art, would present their claim, and the Province of Ontario would awaken to a sense of its poverty in all that tends to develop a sense of the beautiful, of its inability to compete with foreign nations in those industrial pursuits, which demand the employment of artistic taste, and in those higher qualifications, without which, no nation has risen to eminence. Such a Central Library, working in connection with the smaller specialized libraries, would become a centre of light for the Province. Its books with some exceptions, should be placed at the service of every student within its limits, so that a graduate from any of our Universities might be enabled to continue his studies wherever his home is fixed, and the self-taught scholar, however humble his surroundings, brought within reach of the master-minds of the century. Is it among the impossibilities of the future, that the post-office department could be induced to grant a one cent per pound rate for books going and coming from the library to a resident in the Province?

I have from this platform urged the claims of those who are far removed from the centres of education; whose little reading matter is poor and tawdry, except what is obtained from the weekly newspaper, and I wish in conclusion, to say a few words on their behalf. The population of the older portion of this Province is largely agricultural; the new Ontario promises to be a land

of miners. This means that homes are isolated and self-dependent. Our winters forbid the carrying on of farm operations during three months of the year, and the farmer is necessarily driven into his home for much of this time. Would it not be profitable to teach him in his hours of leisure? We have insisted that the children should be educated, and have at great expense planted schools in every portion of the land. Have we no responsibility beyond that? Does education cease with learning the three "R's" or does it not then begin? If so, are we to employ teachers to follow to their homes the young people and there carry on the work we have begun? and what better teachers can we give them than good books? Let them be interesting, well chosen, and they will be read. Once establish the reading habit, even in one member of the household, and you work a revolution in the daily thoughts and daily practice of every member.

Little money is required to start a movement for supplying this want, but much careful organization. Solitary examples of those who see the want and are making efforts to meet it, are already to be found in different parts of the Province, and whether it be to provide printed matter to awaken interest in, or stir the imagination of the members of a lumber or mining camp, or to give to the boys and girls in the solitary log house, some faint idea of the wonders of the world beyond the surrounding circle of woods, all praise should be given for their efforts, however humble. And their example should stimulate us who enjoy so much, to use our influence and experience to systematically carrying out the work they have attempted.

It is probably a dream, which ought to have no place in a building set apart for pure science, but I could look forward to a time when the student in the city or country, would be able to put his hands speedily on the records of the experience of other students, whether of time past or present, on every branch of human knowledge; when every village or town in the Province would look to their public library as their greatest treasure; when in every collection of homes, there would be found those who regularly gathered together for consecutive and careful study of great thinkers, obtaining all the necessary literature required for his elucidation, from some central library, and when every household throughout the length and breadth of the province, would look forward with pleasure to the day which brought the weekly or monthly package of books from the great library. Then indeed, would the Northland be more famous for its learning than for the extent of its domain.

In addressing you upon the shortcomings and deficiencies of our library, I have been led to speak of the wants of our country in the same direction. My predecessor in this chair, upon a similar occasion, forcibly presented the claims of public museums, as scientific aids and popular educators. He recognized, as I have done, the influence which this Institute wields both corporately and individually, and I have no doubt felt as I do, that that influence will be exerted to awaken the citizens of the Province and of the Dominion, to the value of these libraries and museums, and that the result will be, to add to the number of public benefits which the members of the Canadian Institute have been privileged to confer upon their fellow citizens.

RECENT VIEWS RESPECTING THE CONSTITUTION OF THE SUN. BY ARTHUR HARVEY, ESQ., F.R.S.C.

(Read 30th November, 1901.)

At the base of a mountain the view is usually limited and obscured, but the horizon widens and the prospect gains in clearness on the upward climb. Still, when the Alp is scaled, peaks beyond peaks become visible. So in science, and especially in astronomy, some new fact or theory is daily added to the general store, but it is only thereby made evident that there is far more beyond our ken than within it, and we are compelled to think of the last words of Laplace:—
"Ce que nous savons est peu de choses; ce que nous ignorons c'est immense!"

The sun is the orb of which, in comparison with its importance, we know least, and its various phenomena are almost all, as yet, mere riddles. What was thought fifty years ago to be assured knowledge has not held firm, while even modern views as to his constitution are uncertain and indefinite, notwithstanding the array of new facts of which we have become the masters through the aid of the huge telescopes, the perfected spectroscopes and the photographic instruments lately brought into use.

Changed views as to the sun have been forced upon us by the alteration of our ideas about the earth, in which, too, there has been a revolution within a life time.

No longer are we told that the height of our air is forty miles. Auroræ can now with reasonable certainty be numbered among atmospheric phenomena and I have proved one remarkable auroral arch to have been over 150 miles above the ground.* We now know that falling stars light up by friction in the air, and in tracing the path of a remarkable bolide seen in Toronto, I learned that it became luminous at the height of 80 or 100 miles.† The trail of that meteor became snake-like before it vanished, the sinuosities having a breadth of half the apparent diameter of the moon. If these were caused by air-waves, such as Mr. Napier Denison has told us of,‡ these waves had a breadth of at the least 2,000 feet. Laplace, a hundred years ago, said the atmosphere was bounded by a lenticular shaped surface of revolution whose volume is about 155 times that of the solid earth and should reach out to a distance of about 26,000 miles at the equator and 17,000 at the poles. Professor Woodward, lately President of the Mathematical Society of America, appears to agree with him.§ New gases have been discovered in the air, and its constitution is even thought to change as we ascend in it. Carbon dioxide decreases, hydrogen increases and it is thought by some that on the aerial outskirts there is hydrogen alone or with the smallest admixture of the

* Transactions Astronomical Society of Toronto, 1893, p. 78.

† Transactions Astronomical Society of Toronto, 1898, p. 118.

‡ Transactions Canadian Institute, February 6th, 1897.

§ Science, January 12th, 1900.

oxygen and nitrogen which so largely predominate on the surface.* We now know that the higher the clouds are the faster they move and *Ciel et Terre* says that the motion of cirrus clouds is on the average 60 feet a second in latitudes like our own and 45 feet within the tropics, while there are thus currents in the upper air to the violence of which nothing indicates the limits. The word violence I understand implies chiefly velocity and amplitude, for in highly rarefied air, the force of such currents must not be likened to what we should experience if there were at our level a constant gale of from 30 to 45 miles an hour. From mountains and balloons those who frequent high altitudes have often seen below them the upper surface of a layer of clouds, the existence of which surface depends upon a delicate adjustment of heat and gravity. They have described how huge billows will rise from the placid and shining cloud-layer and sometimes subside as quickly as they arose. *Ballons sondes* and high-flying kites have carried instruments which show that there are frequent horizontal strata in our atmosphere, and that the low barometer in one is seldom vertical to the low in another, so that the lowest reading at a height of ten thousand feet may be hundreds of miles distant from the lowest reading at the surface. And the characteristics of these layers are very different. Thus; the outer one, which we never shall reach, must shade off in temperature to the cold of space, dust and moisture never reach it and its inferior surface is the upper limit to the lightest possible cloud. Then comes the air of which the lower limit determines the snow-line on our mountains. Lastly we may place the shell in which we live, within which alone lightning flashes and rains fall, and there is enough moisture to interpose a blessed screen against the terrible cold of a very few miles above. We will not consider the terrestrial hydrosphere and lithosphere because there can be nothing analogous to them in the solar orb, to which we will now turn.

The first scientific conception I can find as to the physical nature of the sun is that of Anaxagoras, who is reported to have said it was a red-hot stone, as large as the Peloponnesus. A hundred years ago it was defined as a glowing solid mass, stationary in the heavens. Even Sir John Herschell in the early edition of his astronomy which I used when a school boy said "it is hardly possible to avoid associating our conceptions of an object of definite globular shape and of such enormous dimensions with some corresponding attribute of massiveness and material solidity." A theory that it was liquid fire prevailed for a time. But it seems to be regarded now as composed of incandescent gas, and I too believe that the sun is a great globe of such vapours or gases, of which the visible outer envelope is as tenuous as the smoke of a cigar.

No sooner had Galileo turned his *perspicillum* on the sun than he perceived its frequent spots, and it was his treatise *Delle macchie solari* which was the ostensible cause of his disfavour with the papacy. Milton, who as a youth visited him, has a half punning allusion to them :—

. . . . "A spot like which, perhaps,
Astronomer in the sun's lucent orb
Through his glazed optic tube yet never saw."

Their nature was mysterious then, and the question as to their cause and nature is not yet surely answered. One plausible theory, which still holds a certain sway, is Wilson's, who thought they were depressions in the luminous solar envelope, through which the dark interior body of the sun became visible. But out of hundreds of drawings, made with the utmost care and minutely examined, less than one in three gives any countenance whatever to this view. Were it true there should be a regular shading off from the circumference of spots to their centre, whereas there are only two well marked distinctions, viz., the black looking umbra near the middle and the more lightly shaded penumbra irregularly surrounding it. The way spots are usually drawn in astronomical journals has become conventionalized; radiations from the centre towards the circumference or *vice versa* are rarely to be seen. Moreover, this hypothesis assumes the interior layers to be less luminous than the exterior, which, as they cannot well be cooler, is improbable. Another theory was that the spots are scum or slag, floating on the surface of molten matter, but if the visible surface be

* M. G. Heinrichs, *Comptes Rendus de l'Academie*, August 30th, 1900.

not liquid, it must be abandoned. I have seen a large dark spot which seemed to show on the western limb as an indentation, but the effect might be produced by a dark mass covering a considerable surface or by the obscuration of that surface otherwise, and I incline to the belief that some emission from the interior spreads over the surface of the photosphere in the form of vapour, some matter which impedes the transmission of radiations giving light and perhaps heat as their effects, but does not so impede or absorb the radiations which carry electrical charges.

Whatever may be the cause of spots, they were seized upon as affording means for determining the time of solar rotation, and Sir John Herschell, in his *Astronomy*, edition 1842, thus summed up this branch of the subject :—

“Our telescopes show us dark spots upon its (the sun’s) surface, which slowly change their places and forms, and by attending to whose situation at different times astronomers have ascertained that the sun revolves about an axis, inclined at a constant angle, of $82^{\circ} 40'$ to the plane of the ecliptic, performing one rotation in a period of 25 days, and in the same direction with the diurnal rotation of the earth.”

Some further elements of supposed precision having been introduced by Mr. Carrington, the Greenwich Observatory adopted and keeps to a rotation period of 25.38 days, sidereal.

I found, however, as a very casual observer may easily do, that this period did not suit the spots I examined, with a view to discover if there were not permanently active regions on the sun, answering to volcanic districts upon the earth. The changes in spots seemed anything but slow, they drifted in irregular ways, both in latitude and longitude, and when after disappearance they again emerged at about the same region, the time was not sufficiently exact for identification. So, as the attitude of a student towards all science should be one of scepticism, following the advice of St. Paul to the Thessalonians, *πάντα δὲ δοκιμάετε*, judge for yourselves about all things, I began to see if I could not ascertain the exact period of solar rotation for myself, by less difficult and more certain means than the observation of spots. I sought for and thought I had found it in the periodicity of outbreaks of terrestrial magnetism. My theory was that the internal convection-currents bringing intensely heated matter from the sun’s interior towards his surface would cause solar disturbance which in some way would be radiated in pencils, like beams from search lights, from the sun to the earth, that such convection-currents would follow established lines, and that whenever the particular solar locality was turned towards the earth, there might be a magnetic effect here, and surely would be, if at the time that solar volcanic vent were active. I found from the whole series of Toronto observations, which began in 1844, that one magnetic storm repeated, intermittently, but continuously enough for a preliminary identification, in 27.24575 days synodical or 25.35447 days sidereal.*

Two new announcements bearing on the subject were made about that time. One was that cathode rays, which exist in abundance in solar radiations, carried with them charges of negative electricity. Mr. H. Deslandres communicated to the French Academy in 1898 his discovery to that effect, and shortly afterwards it was added that Lenard and Becquerel rays, emitted by radio-active substances, have the same property. This solved the perplexing question, how could electricity be radiated across space, in which there is no permanent conducting medium. The other was that the spectroscopists, who have now perfected their instruments so that they can tell the rate at which a luminous body is moving towards or away from them, announced their agreement with the astronomers who had been doubting the uniform rotation of solar spots. The sun being two and a half millions of miles around, and rotating in 25 days, the velocity of its rotatory movement at the equator is a mile and a quarter per second. Thus a point at the equator is approaching us at that rate when it comes into view, and receding as it vanishes. The rates of approach and recession vary with the distance from the equator of the locality under observation, but are quite sufficient even near the poles to noticeably shift the dark lines of the solar spectrum nearer to the blue end in the one case and to the red in the other. The

* Transactions, Astronomical Society of Toronto, 1897.

most painstaking observations are perhaps those of Crew and of Duner, which have been worked out by three different formulæ and give as results :—

Rotation period at the equator.....days 25.53 ; 25.71 ; 25.50
Rotation period near the poles.....days 37.66 ; 49.45 ; 45.98

Bringing such periods to the measure of velocity we have the materials for a table in which ϕ . is the latitude, v . the velocity, while v . sec. ϕ . is the velocity at the equator corresponding to that observed at the various latitudes.

ϕ .	v . per Second in Miles.	v . Sec. ϕ .; Miles.
0°.4	1.23	1.23
15	1.15	1.19
30	0.98	1.13
45	0.74	1.04
60	0.46	0.92
74.8	0.21	0.81

It is evident that if the sun rotated as a solid, all the values of v . sec. ϕ . should work out the same, that is, to 1.23 miles per second. But the table shows that the region in latitude 74° 8' rotates one-third less swiftly than it would on that supposition. Something analogous is found in connection with Jupiter's rotation, for his cloud-belts differ in their rate of movement, though not nearly in the same proportion.

The consequences of this discovery have not all been reasoned out, and, as Crew does not completely agree with Duner, further observations are necessary, but the view that the gases at the visible surface of the sun are extremely tenuous is much strengthened. A rotation of a solid sun in sections is unthinkable; there can be nothing approaching to solidity where there are such varying rotatory rates. Yet at a depth not far below the surface there must be density enough to make the great gas-ball more coherent, and as the density increases the substance must tend more and more to act as a viscous if not as a solid body. The sun therefore appears to rotate more slowly in depth than at the surface. Again, since the more rapid the rate of rotation the greater the centrifugal force, the convection-currents from within the sun must be directed towards his equatorial belt, they must acquire additional force in proportion as they are so deflected, which is not an improbable reason for the excess of solar energy manifested near his equator.

To treat of the Corona which envelops the sun, and has up to the present time only been seen during total eclipses, would be foreign to the purpose of this paper. It may, however, be remarked that attempts have been made to determine whether it rotates too, and at what rate. I have only heard of one successful observation, made by Deslandres in 1900, who thought it rotated faster than the sun, so far at least as its west side was concerned.

Already, however, we can picture to ourselves the sun as a star surrounded by a nebula of which the greatest extension is about its equator and revolves with something like planetary velocity. It does indeed seem that the materials of which the solar system is composed have not yet been completely absorbed into the sun and his planets, but that a remanet still girdles him and is seen in the Corona and especially in the zodiacal light.

What is it then that causes so sharp a distinction between the visible disc of the sun and the nebula outside it? Seen through powerful telescopes it is as definite as it appears to the unaided vision, it does not shade off by degrees like comets' tails or nebular wisps. I have thought that the cold of space prescribed the limit, that there is a line beyond which solar vapours cannot incandesce, like that which limits the height of clouds upon the earth, alluded to at the outset. Therefore, as I do not learn that any variability has been observed in the sun's diameter, I have not been an enthusiastic supporter of those who think the sun's

condition gives hot or cold seasons to the earth. If from any cause the sun did emit more heat one year than another, the first effect, it seems, would be the expansion of his own visible disc. Nor does the answer given by Schmidt, of Stuttgart, make this objection less weighty, whose work of 1891 has been recalled and further explained by Otto Knopf, of Jena, in 1893. They do not think that the light reaches us from the solar surface; in a word, they deny that there is a definite surface to the sun. They say his light originates within a globe of super-heated gases and that, owing to the refractive index of these gases being reduced through diminished density as the external strata are reached, the rays from within the sphere necessarily appear to be limited by a circle. They think the spots are not upon what looks to be a photospheric surface, but below it, and even suggest that they may be optical phenomena due to disturbances of the refracting properties of the superior layers. Their theory of the spectrum is necessarily unusual too. The solar spectrum was long supposed, following Kirchhoff, to originate on the photosphere, which he considered liquid, and covered by an atmosphere which by absorption caused the well-known dark lines. Schmidt and Knopf think the violet and blue rays originate in a smaller concentric shell than the red rays, under greater pressure, and that having to pass through a denser medium throws them farther along the spectrum. The visible circumference of the sun being unreal, the absorption lines may have their origin at a considerable depth within the solar atmosphere, which they think is so rare in the shells outside the incandescent strata as to have very little absorptive effect.

That the sun does emit more heat at certain periods than at others, varying according to the extent of spots upon his surface, seems to be the opinion of the day, though our own Canadian records do not indicate the slightest periodicity, excepting in so far as rain-fall is concerned (where there is a certain periodicity which may be due to heat elsewhere). But there is no doubt there is a somewhat ill-defined term of more or less spottiness, called the sun-spot period. If we cannot as yet certainly connect it with radiations of additional heat or of light, we can certainly trace its concordance with the varying intensities of the earth-currents of electrical force. In my paper for our semi-centennial memorial volume,* I brought down to that date my own studies on the subject, and to avoid repetition, I refer thereto, especially as that was the first publication of my discovery that the solar disturbances which cause sun-spots and our magnetic storms and auroræ also cause simultaneous excitation in the tails of comets and in the condition of other planets. There has been no doubt since the publication of Professor Loomis' papers in the American Journal of Science, many years ago, that the curve of magnetic excitement followed very closely that of sun-spottiness, and the curves which prove their similarity have been brought down to the present date by Mr. W. Ellis, F.R.A.S., attached to the Greenwich observatory. Shortly after the date of my paper just referred to I made a curve from the differences between the observed brightness of Encke's comet at its many apparitions and the brightness it should have attained if distance from the earth and sun had been the only factors to be considered. That investigation, published in a Presidential address to the Toronto Astronomical Society, showed that the excitation of that comet has always corresponded in a most remarkable way to the magnetic excitation of the earth, and therefore to the condition of the sun.†

We have, however, been passing through a period of minimum solar excitation, and I have on that account been giving less attention to phenomena expected at active periods than to those which can be studied within walls and ceilings, and I have nothing new to say on that subject.‡ I find, however, that I have not yet communicated to the Institute my demonstration that antarctic auroræ are synchronous with auroræ boreales. This I was able to prove from the observations of that painstaking and thorough meteorologist Henryk Arctowski, now of Liege, who was with Commander de Gerlache on the *Belgica* during her antarctic sojourn. His table of auroræ seen in *Belgica* Straits, far to the south of Cape Horn, answers precisely to the table made from Canadian and Washington

* Transactions, Canadian Institute, 1898, 1899, p. 345.

† Transactions, Astronomical Society of Toronto, 1898.

‡ Since the reading of this paper, the author has found reasons for believing that the zodiacal light also brightens during magnetic disturbances.

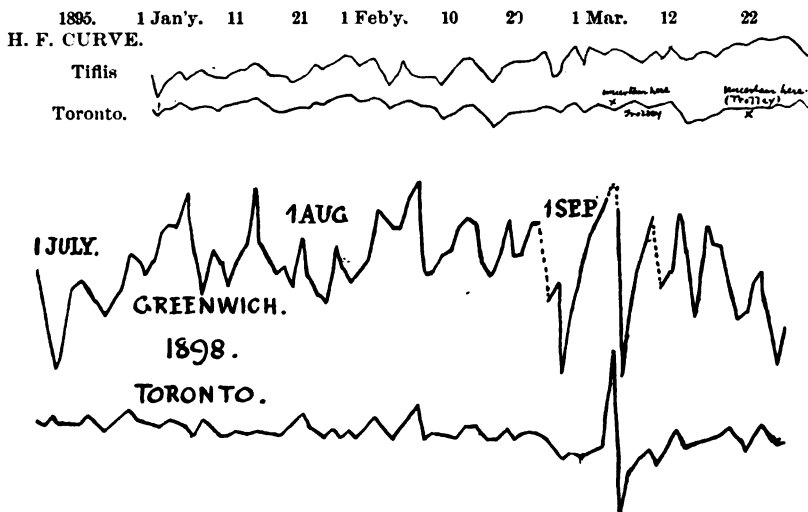
observations. Mr. Arctowski, in an address to the Royal Geographical Society, published in its *Journal*, called on northern meteorologists to see if there were any correspondences between these Auroræ, Australes and Boreales, and it is, I think, extraordinary that the *Journal*, with which we exchange, should have lain on our table for a month before I saw it, and that even then I should have been the first to answer the appeal. But as our President remarked, there is a sort of justice about this affair, for it was to trace out magnetic similarities and differences in the two hemispheres that the Toronto observatory was established, sixty years ago, and it is to its admirable continuous work and the courtesy of its director that this concordance of Arctic and Antarctic auroræ has now been determined by a Toronto amateur. I need scarcely add that magnetic disturbances have also synchronised with Arctowski's most brilliant auroræ. That synchronism as regards our northern lights is treated of on page 352 of the memorial volume above quoted from. We have thus additional proof of the cosmical bearing of auroral phenomena and can mentally see the spectacle of earth, receiving electrical discharges by means of cathode rays thrown off during solar disturbances, and lighted up around both poles with the lovely coruscations accompanying the distribution of this electrical surplus.

Is it permissible to enliven the course of a scientific discussion with the spice of romance? In the papers by Arctowski I noticed one dated at Liege, where a daughter of mine was studying at the Conservatory of Music. I wrote, enquiring if Liege were Mr. Arctowski's permanent residence, and received an answer that she had the pleasure of knowing him, and she was going that evening to Madame Arctowski's house. Did I know he had been lately married, and how it came about? Supposing I did not, she would tell me the story. When the ship was in the ice pack, the four chiefs of departments were in their little dark cabin, with just light enough to see by, and they were amusing themselves by turning over for the twentieth time the pages of year-old magazines. Subject for discussion—which was the best looking girl of all whose portraits were figured there? Each made his choice and gave his reasons, and Arctowski, cutting out the picture of an American then in Paris, put it in his pocketbook and vowed that if he lived to get back to Europe, he would find that fair woman out and marry her. And so he did. May the pair enjoy to the full the wedded bliss which had so strange an origin!

Mr. Arctowski's letters were insistent on a further point. Were the characteristics of the auroræ seen here at given dates similar to those which he observed at corresponding dates in the southern hemisphere? He thought Toronto was more homologous than any other station as to position with respect to the northern magnetic pole to that which the *Belgica* had occupied with respect to the southern. Observations of the auroræ here were unfortunately not in sufficient detail to give an answer to the question, but I was able to obtain fifteen or sixteen reports from the United States Weather Bureau which were of service in establishing a presumption that it must be negative. At the date of an aurora which Arctowski would describe as waving curtains of yellow light, the aurora here would as often as not be seen as almost stationary auroral clouds. More puzzling still, the aurora was not seen in equal brilliancy, of corresponding colour, or of similar rapidity of motion in the different stations here from which it was reported. In two of the instances given by Mr. Arctowski, there was a clear sky in our latitude from the Atlantic to the Pacific. But the local distribution of the auroræ observed was singular—in one case they were reported all over the north-eastern States and our Maritime Provinces but were not seen west of Toronto until the region was reached which in both the United States and Canada adjoins the Rocky Mountains. In the other case the display was not seen east of Toronto or far west of Minneapolis. I wrote a paper on this subject for the Royal Society of Canada, as complete and as brief as possible, but that Society is very dilatory with its publications and appears to care more for literature than science. The fact is probable that atmospheric conditions, other than clouds, interfere with the visibility of auroræ, and hence the erroneous opinion that because magnetic storms are not everywhere accompanied by auroræ, the connection is not fully established. It is, however, possible that longitude has something to do with the location of auroræ, and that Arctowski's "homologous" positions will have to be

reckoned with. It may be that a broad tongue of electrical influence shoots from the north towards the equator, and that another issues from the south to meet it at the rendezvous. A study of the few auroral observations made by Borschgrevink when he was in the Antarctic on the "Southern Cross," which have been tardily issued, favours this inference. His station was on the other side of the globe; we had here the magnetic depression to accompany, but not in all cases the auroræ, which may have illuminated the northern Pacific ocean more brightly than this western region.

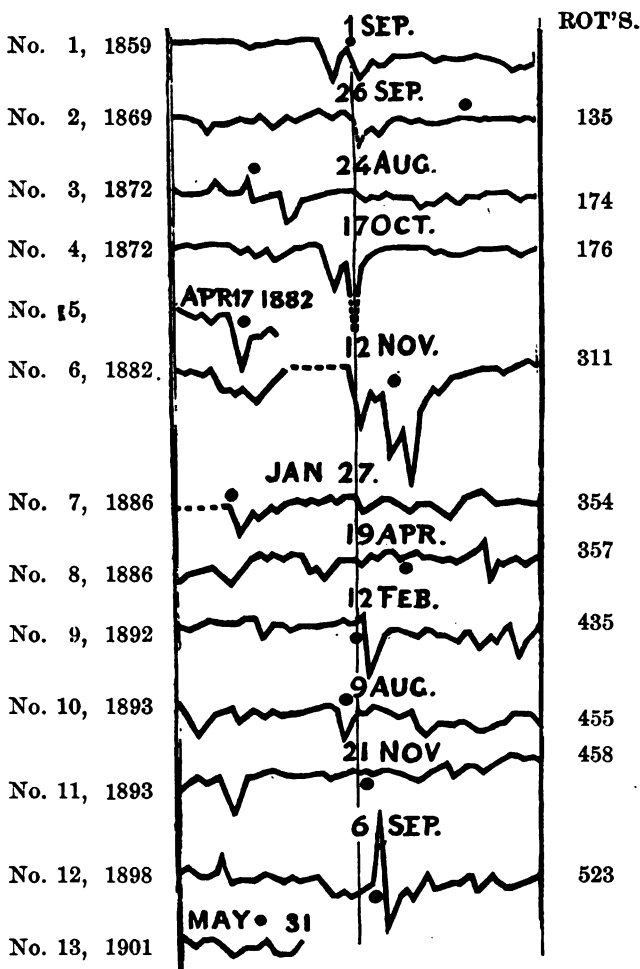
I have searched available records for further proof of the statement respecting the connection between sun spots and magnetic storms made at pages 351 *et seq* of our Memorial Volume, and present a diagram which shows the magnetic disturbances associated with the most noteworthy sun spots of recent years. I begin with the magnetic disturbance of the end of August and beginning of September, 1859, because it is somewhat celebrated in astronomical history, and has given rise to a fabulous legend. Most popular works on the subject of sun-spots report that while Messrs. Carrington and Hodgson were examining the sun they saw a spot appear and there was a simultaneous disturbance of the magnets. The original statement of Mr. R. Hodgson, F.R.A.S. was made to the British Association as follows:—"While observing a group of sun-spots on September 1st, 1859, I was suddenly surprised at the appearance of a very brilliant star of light, much brighter than the sun's surface, most dazzling to the unprotected eye, illuminating with its light the upper edges of the adjacent spots . . . It lasted five minutes and disappeared instantaneously. From a photograph taken of them at Kew the previous day the size (length) of the entire group appears to have been about 2' 8", or say 60,000 miles. The magnetic instruments at Kew and at Greenwich were simultaneously disturbed at the same instant to a considerable extent." I assume that the sun spot group was central at that date, and the magnetic curve is taken from the Bombay register as we do not possess the 1859 Greenwich records. The whole world, however, feels these magnetic disturbances with wonderful simultaneity. Here are two examples of the curves



CURVES OF HOR. MAGNETIC FORCE. DAILY MEANS.

for three months' daily mean readings of horizontal magnetic force; one pair Toronto and Tiflis, the other Toronto and Greenwich. Allowing for differences in scale, you will see that the ups and downs exactly correspond. Even the principal tremors are to be seen on the photographic curves now made at quite distant places, such as Paris and Perpignan, Berlin and Vienna, Manila and Zi-ka-wei, and so exactly to the instant that the difference in longitude can be checked by this strange wireless telegraphy. The beginnings of magnetic storms

are often noted by a jerk in the regularity of the trace, and this appears to be observable at every station. Returning from this aside, I will ask you to examine the magnetic tracing for the year 1859. You will see that Carrington and Hodgson's disturbance was fairly severe on April 21st, May 19th and June 16th, strong on July 11th, slight on August 8th, and very severe on September 2nd. These various dates are separated by about the interval of a solar rotation, and I have arranged the other curves so that the same solar meridian which faced the earth on that September 1st, also faced it at the dates placed underneath it in all, adopting my own rate of solar rotation. It differs from the one adopted at Greenwich by 3/100



of a day only, but in the forty years covered by these curves that equals twelve days or nearly half a solar rotation. With the uncertainty above referred to as prevailing in reference to this exact period I need scarcely say that we should not yet be too positive of correctness. The concordances apparently established by my diagram and table may be accidental. The diagram is made to show that great spots are associated with magnetic storms, and each of the curves gives some noteworthy proof of this fact; their being placed under each other has an independent bearing upon the other fact as well. I have taken all the great spots of which I have found an account in the volumes accessible to me.

In an old "London Almanack" I find there was about central on October 13th, 1869, a huge spot, 672,000,000 of miles in area. I therefore had to plot the magnetic curve, No. 2, and it seems to show that the disturbance repeats after 135 rotations, but the spot has no relation to this storm; it may, however, be the outcome of the solar disturbance which caused the depression of September 14th, a rotation before. The next curve, No. 3, is plotted to show at August 25th, 1872, the beginning of a storm which culminates on October 17th—176 rotations. It also shows the association of a spot and a disturbance in the beginning of August, both of which are on another disturbed meridian which shows magnetic effects in all the subsequent tracings and has spots associated with it in Nos. 5, 7 and 13. The two curves Nos. 5 and 6 are given because of a paper in the "monthly notices" of the Royal Astronomical Society "On the great sun-spots of 1882, April, also November 12th-15th." The day of centrality in April is not given, but on the 17th there was a magnetic storm so violent that it could not be completely registered. It can be traced back to September 12th and October 9th of the previous year. The November sun-spot is in the middle of a long and pronounced disturbance of the needles, the beginning of which is 311 rotations subsequent to the storm of September 1st, 1859. In the "monthly notices" there is a paper "on a remarkable sun-spot of 1886, April 24th." This is an instructive occurrence because there was no remarkable disturbance of the magnets along with it (see curve No. 8), but there was a disturbance on January 8th and 9th, with an accompanying spot; there was another on March 31st, which apparently gave rise to the spot which appeared the month after. In these curves, especially in No. 7, the commotion with which it began may be seen to continue. Curve No. 9 shows the depression figured in detail by the late Professor Carpmæl in the frontispiece of the Transactions of the Astronomical Society for 1892, which produced the celebrated rose-auroræ of February 13th, and what the Royal Astronomical Society's notices say was an exceedingly large composite spot, the largest up to that time ever recorded. I observed this spot with care and submitted a series of drawings of it to our Astronomical Society. The spot had appeared during the previous rotation, January 8-12, and the magnetic disturbance, which can be traced back to September 25th, 1891, continued as regularly as could be expected, considering the immense solar area involved, well into 1893. You may see that it kept on causing spots, shown in curves Nos. 10 and 11. The Toronto Astronomical Society records in 1898, September 2nd-15th, a spot 65,000 miles long and 75,000 miles broad, belonging to a disturbed area 150,000 miles across, and curve No. 12 shows the great magnetic depression which immediately followed it. Lastly I give the location of the spot of May of the year 1901, which is rather celebrated, though not a very large one. The Abbé Moreux, of Bourges, first saw it on May 20th, when it was so active that he thought the solar spot-minimum had suddenly passed away. His vivid description of its rapid changes of form and division into two main parts startled the world, who expected a scorching summer in consequence, a fear which I attempted to allay by showing its small comparative importance and the absence of great magnetic disturbances connected with it. Its activity may, however, yet be important to science, as it was just on the edge of the sun at the time of a total eclipse, and we may hear of moderate coronal disturbances near the latitude it occupied.

Physicists and astronomers are indeed now beginning to admit, with apparent and unaccountable reluctance, the intimate connection between the two effects of a common cause, sun-spots and magnetic storms. Mr. Wm. Ellis, F.R.S., says: "the general effect observable is that in our latitude there may be at one time a large solar spot with great magnetic disturbance . . . at another time a considerable solar spot may appear without accompaniment of unusual magnetic movement; and again, magnetic disturbances may occur without any noteworthy spot." The "general effect" is not quite fairly stated, even by this most cautious and painstaking official; there seldom if ever is a great spot without a magnetic storm with which it can be connected, usually while it is visible, occasionally a rotation before. Mr. Ellis does not seem to have quite freed himself from the old idea that spots cause storms, or fully to recognize either the cosmical nature of magnetic phenomena or their effect all over the earth, else why does he allude to

"our latitude?" The converse, as he puts it, that there are magnetic storms not accompanied by spots, proves little—the cause of the storm may have been in a solar region where spots do not appear, or, for reasons we cannot think of, may not have given rise to spot phenomena.

Several astronomers still cling to the idea that to prove the connection a spot must be absolutely central at the time of a magnetic storm. The diagram just explained shows that the spot often lags a day or two behind its related storm. It also indicates that there are three active meridians on the sun. I am not yet prepared to speak of the latitude of active spot regions, but I have checked the prominences for several years, and while they too are apparently more numerous on three meridians, they are strangely distributed in belts, like those of Jupiter and Saturn, while there seem to be extensive regions of comparative quietude. I find that Professor Wolfer, of Zurich, has been doing similar work, and his results, which I have seen in the *Memorie* of the Society of Italian Spectroscopists, are apparently the same as my own.* As I have worked out each year separately, the question of the exact rate of rotation is not seriously involved. I do not at present attach a high value to this work, but it is interesting as showing changes in the latitude of prominence belts. Some years this activity extends to near the poles, and we have a belt of prominences in latitude 80° . The next year it may be five degrees or even more nearer to the equator. Sometimes prominences are numerous in the northern solar hemisphere, and again the southern hemisphere may exhibit more activity. Prominences often occur in the neighborhood of spots, but frequently where none are visible, and the range of prominences is much greater than that of spots, for they have been seen at the very pole. I have not been able to discover that they affect the needle in any way, though they are more frequent and larger when sun-spots are many and magnetic disturbance great.

I must not conclude without a notice of the labours of Dan Carlos Honore, director of the International Solar Institute of Montevideo. Like myself he found it needful to arrive at a true period of solar rotation but he pursued the meteorological method. Professor Frank H. Bigelow, of Washington, D.C., had already shown similarities between magnetic curves and North American temperature waves, and by making a time allowance for the movement of pulses of heat and cold from the Rocky Mountains towards the Atlantic Coast, he brought them into tolerable harmony. Mr. Honore does not attack this concordance; he takes as a guide the normal temperature of each day, attributing the surplus or defect of heat to radiations from the sun. The days of surplus heat are shown in his figures on one side of a circle and the days of excess of cold on the other, he then finds a marked periodicity, and declares the synodical solar rotation to be 27,241,326 days. I understand he thinks the solar shell from which we get the most effective heat rotates in that time, and if the shell which causes electrical manifestations rotates a little more slowly, according to my reckoning, there is nothing contradictory in that difference. Mr. Honore has so much confidence in his theory that some parts of the sun are hypothermic, and cause an excess of heat when turned towards the earth, that he has prepared tables of solar rotation covering hundreds of years. On dividing the year into two, and superimposing the curves, he found an inequality, and concluded that there is an interior sun, with an axis slightly inclined to that of the photosphere, and a rotation slower by 0.00867 of a day, which leaves 363.33 days for the heliothermic year and 27.25 days exactly for the synodical rotation of the interior sun. With these data Mr. Honore thinks he can define the latitude as well as the longitude of the solar regions on this interior sun which send us heat, and even by those whose radiations he believes cause earthquakes. He has sent me diagrams of solar thermic centres, calculated by his tables, also other diagrams which localise the solar seismic centre, which he thinks controls the Mexican volcanic field in a seismic circle of 15 heliothermic years, or 200 synodical rotations of the interior sun. With this cycle he identifies every one of the long list of Mexican earthquakes published by the Antonio Alzate Society. I have the calculations, not yet carefully examined.

I think the sun's condition does influence the earth in the matter of cold and hot days, but the number and area of sun spots has but a slight connection with

* Vol. XXIX, dispensa 7a.

that particular irregularity. In Toronto there is evidently no settled relation between annual temperatures and sun-spot frequency. Many times sought for, any correspondence whatever has eluded the researches of others besides myself. But this is the worst of places in which to look for periodicities in weather, the areas of low barometric pressure coming from the Rocky Mountain districts may go a hundred miles north or south of us, and thus introduce a disturbing element which baffles investigation. Even a slant of wind off the lakes may cool the shores, or its absence heat them, and thus disturb the temperature of any given day. It is in Tropical regions and in places where storms of wind and rain with thunder and lightning are rare, that we may probably discover a periodicity corresponding with that of solar rotation, and perhaps even find a temperature curve agreeing with the sun spot cycle; but such changes must be very slight, on the general average, and it is the height of absurdity to hold the sun responsible for a great excess of heat or cold lasting for a whole season. The excess or defect of mean temperature, at Toronto above or below the average is seldom a degree, and has never been known to be four; very hot seasons here are probably balanced by cool ones in other parts.* We are therefore working on very small margins. This is natural, since the sun and the earth are not in their youth. Lord Kelvin has reduced his estimate of the time the earth has lasted since the first crust covered its surface from a hundred million years to forty, but though I side with the geologists who think a hundred millions are too few, yet in this connection I can be content with the smaller number as an estimate. For, before its crust formed, there were long aeons during which the earth was an agglomeration of mere vapours. Nor is Terra the first born, but, with Venus, is a daughter of the sun's old age, while Mercury is his Benjamin. Mars, Japiter, Saturn, Uranus, Neptune, and probably another, are his elder sons. The sun then has had time to become fairly steady. Being a ball of gas, convection-currents are probably doing their work quietly; the solar disturbances cannot be of the nature of a terrestrial eruption in which the violence seems to be determined by the resistance to interior forces of an exterior crust. The spots float up from the places which these convection-currents disturb, and as stated at the beginning of this paper they are probably nothing more than large quantities of vapours much attenuated on reaching the surface, possibly absorbent of light vibrations, certainly so constituted as to interfere with them. But though these produce the primary effects of solar disturbance but slight secondary effects here, there is something irresistibly attractive in observing them and endeavoring to account for their origin and nature.

* The average in Toronto since 1840 has been 44° . In 1875, the average was $40^{\circ}.07$, and in 1880 it was $47^{\circ}.02$.

SUN-SPOTS AND WEATHER CYCLES. BY A. ELVINS.

(Read 15th February, 1902.)

We all feel interested in the *weather*, our personal comfort and the prosperity of our country depend very much on it. Some seasons are *early*, some *late*; some *wet*, some *dry*; our *farms* and *gardens* are productive or the reverse, as the weather is favourable or unfavourable; the opening or closing of navigation, whether it is early or late, depends on the weather, and this is important to our sailors, and to trade and commerce generally. If we could foretell the *general character* of a coming season we could act, so far as possible, to meet coming conditions.

Nations have seen the importance of knowing the climate of the different parts of the earth's surface and have erected and maintained observatories where observations are made and preserved. From these records the *mean* meteorological conditions existing at such localities are known.

But the *extremes*, rather than the mean conditions, are what is needful to be known. Every one knows that we sometimes get a *wet* spring, and on other years a dry one. Our pastures are some years green in summer, at others dry and parched. In 1843 and again in 1878 we had above 43 inches of rain at Toronto, and less than 18 in 1874 and 1887. *What can be the cause of these changes?*

We know that our summer results from the northern hemisphere of the earth being then turned sunward, and our winter from the same hemisphere being turned from the sun, and we naturally turn to the sun and try to find an answer to our question *from it*.

Ever since the invention of the telescope the sun has been an object of great interest to astronomical observers; sometimes it is a spotless globe of light, and at others, one or more spots are seen on its surface. They break out unexpectedly, exist for a short time, occasionally two or three months, and gradually disappear. Some of those spots are of great magnitude. I have seen some more than 100,000 miles in length, or rather the group has been that long. In and around these spots the sun's surface seems very much disturbed, and with the aid of the spectroscope great uprushes of gases can be seen rising to an enormous height; and we are led to ask if those great solar outbursts, sun-spots, etc., are not the cause of our weather changes.

I shall have to return to those sun-spots, but here I shall diverge a little to refer to another fact. When a magnet is suspended so as to move freely on a pivot as in surveying instruments, and properly protected from local disturbances, it points in a definite northerly direction and is as a rule stationary. But it is not always without motion; sometimes it vibrates from side to side of the main line, and this continues for a time, and then disappears. This is known as a *magnetic storm*.

Such magnetic storms are found to be more frequent when the sun is much spotted than at other times, and it has been thought that these *storms* are *caused* by the disturbance on the sun, which disturbs the ether of space, and the magnetism of the solar system; that is, that magnetic storms are the result of the outbreak of sun-spots, or as Mr. Harvey thinks, of the disturbance to which the spots themselves are due.

There is also another phenomenon which must not be overlooked, that is, *auroral displays*. We at Toronto have had good opportunities of studying these, for we have been well situated for their observation during the past century, and the displays have been frequent and very grand. Like the disturbance of the magnetic needle, the auroral displays are more frequent and brilliant when the sun is most spotted, and when we plot the number of occurrences in a curve for many years we find the sun-spot curve, the curve of magnetic disturbance, and

the auroral curve, to be so nearly alike that one curve differs very little indeed from the other.

It seems almost certain that the disturbed condition of the sun must produce magnetic and auroral disturbances, or that some common cause produces *all three*.

Careful observations have established the fact that there is a periodicity, somewhat irregular it is true, but still a periodicity, from one maximum of those phenomena to the next following, the period being eleven years and a little over, and the curves of all three phenomena are so nearly alike that the coincidence is unmistakable.

These coincidences require to be examined with care, and we should find which is the cause of the different phenomena, or if some cosmic condition may, or may not, produce all of them.

Are there any facts which show if the magnetic storm is caused by the outbreak of spots, or whether they are both the effect of some common cause?

There are two important facts which seem to me to help us to answer this question.

(1) Many *magnetic storms* have occurred when no spots have existed on the sun.

(2) Large spots have broken out and run their course, and no magnetic storm has been observed.

It seems from these two facts that the many synchronisms which undoubtedly exist, must be chance coincidences, and not that the sun-spot caused the *magnetic storm*.

Let us now look at the *auroræ* which are also numerous at the time of sun-spot maximum. *First*: We frequently get magnetic storms when fine auroræ are visible, and we sometimes get magnetic storms when no aurora is visible here, but we *never* get a fine aurora without a magnetic storm coincident with it.

This seems to show that the *aurora may cause the magnetic storm*, but that the *magnetic storm cannot cause the aurora*.

And even the magnetic storm which sometimes exists when no aurora is visible here, may be the result of the descent of auroral matter somewhere near. Mr. Stupart speaks of a distinct auroral display observed by him when returning from the North-West, and though we had no aurora here, the chronograph showed a disturbance of the needle at the same time.

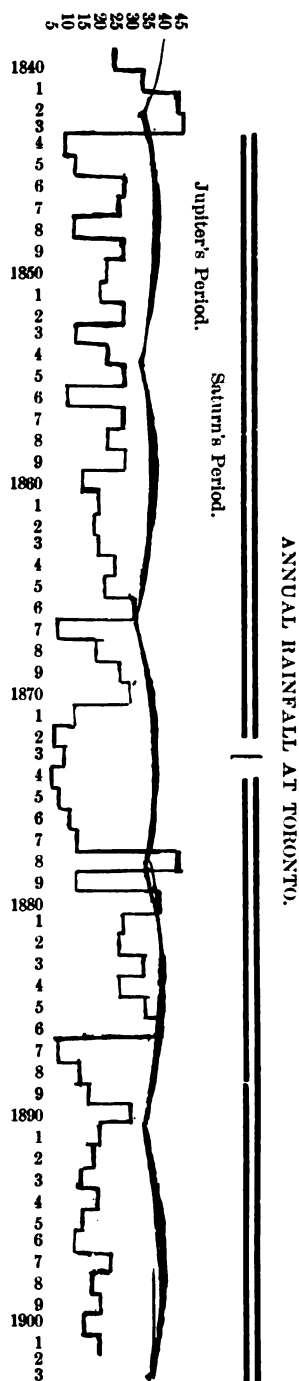
For the cause which produces the three phenomena we must look into the space in which the solar system exists, and the space through which it moves. Is it possible to find what the disturbing cause is?

I do not think that we can say with certainty; but there are reasons which lead me to think the disturbing element is to be found in the cosmic or meteoric matter existing in space, and which must be revolving in orbits around the sun, and possibly in a far less degree around the planets also.

Proctor in his "Other Worlds," Chapter ix., proves clearly enough that the solar system, especially near its centre, is crowded with meteors of all sizes, from almost invisible particles to masses of many tons weight. (Page 191., 4th edition) he says: "we recognize how erroneous that opinion is which an eminent astronomer recently expressed, who asserted that the united weight of all the bodies other than the planets in the solar system must be estimated rather by pounds than by tons." His reasons are convincing, and lead justly to the conclusion "that the aggregate weight of the various meteoric systems circulating around the sun must be estimated by billions of tons rather than by ordinary units."

Can we not go a step further? I have long thought that the atoms of the chemical elements may and do exist in space; if so, such would be as obedient to the laws of motion as larger masses are. In fact, all aggregations of *physical particles* (which in my papers on "Moving Matter" I have called *atoms*) will be subject to the same laws as large masses or worlds.

And perhaps we need not stop here. I have long thought that the chemical atoms are themselves aggregations of smaller particles, and these again of particles smaller still—the ultimate particles, or primitive atoms—those being the units of which all masses are built up; and that the chemical atoms are formed in space and should be regarded as of celestial, rather than of terrestrial origin.



The above diagram shows the rainfall in each year since 1840. The arcs of a circle represent the periods of Jupiter of which there are five. It will be noticed that each period ends with a heavier rainfall than the average, and this is followed by a dry year. If this is a law we should have a *wet* year in 1902 and a dry one in 1903. But as the more distant planets Saturn, Uranus, and Neptune will be disturbing factors a year plus or minus may be possible.

The late investigations of J. J. Thompson and of Arrhenius, on fractional portions of the chemical atom, seem to me to be in harmony with the views expressed in this paper.

All such cosmic matter within the sphere of the sun's influence will be gathered into the solar system. Let us try to follow their course when they pass toward the sun.

Masses coming into the system move rapidly around the sun and as a rule pass off into space; they may sometimes collide with other masses moving in opposite directions, and as this would destroy their projectile force and shatter the masses, some of the fragments will in such cases fall on the sun. The planets as well as the sun will receive cosmical matter, and I think the meteoric showers which fall on the earth are but a small fraction of the matter which is constantly being added to its mass. The ultimate particles existing in space must be aggregating and forming chemical atoms; these enter our atmosphere and form part of it.

I have frequently observed the beautiful auroræ with which we in Canada are so often favoured, and I could not repress the conviction that some attenuated form of matter was descending through the atmosphere from a radiating point above us, when the arches passed roughly from east to west, with waves of light near the zenith passing westward, and especially when a corona has formed at the zenith. Streamers radiating from that point reminded me so very forcibly of the meteoric shower of 1868 that I could not doubt but those radiating beams of light were the result of matter of some kind falling on the earth, as the star showers are known to be.

This view of the aurora finds support from the fact that bright meteors have been seen to fall passing parallel to the direction of auroral streamers, and the fact that the magnets in the Observatory of Itataya were violently disturbed during the fall of a meteorite which fell or rather passed very near it. (See note, page 119.)

We thus find a reason why magnetic storms, auroræ, and sun-spots are most numerous at the same time, namely, that a larger quantity of cosmic matter is in the central part of the solar system than at other times, which falling on the earth produces auroræ. The auroræ cause the magnetic storms, and large masses fall into the sun, producing sun-spots.

It is now time for us to ask if this affects the weather? To answer this question we must ask why more cosmic matter exists near the earth sometimes than at others.

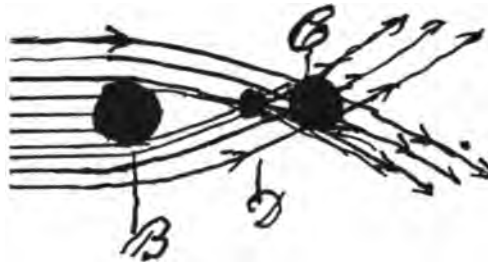
If no planets existed moving around the sun in the same plane, our weather would be less varied. It is the action of the outer planets on the incoming cosmic matter which condenses it in some parts, causing it to move in streams at

some points, and scattering it in others, which projects incoming matter in paths sometimes wide off the orbits they would have followed but for planetary action.

The sun has a sphere of attraction beyond which its influence is practically nil; but the dimensions must be enormous. From the remotest parts of this sphere cosmic matter moves sunward, very slowly at first, but increasing its rate of motion as it draws nearer and nearer to the solar system. The distance from our system will be so vast that off in space the lines of their motion must be practically parallel.

And here it should be understood, that no matter whether my speculations as to the origin of the chemical elements are correct or incorrect, the fact remains that cosmic matter, solid and gaseous, really exists in space, and moves in orbits around the sun, and so far as the weather is concerned it does not matter how they originated.

Matter coming from beyond the orbit of Neptune, will, when moving in the medial plane of the planetary orbits pass near the orbits of Neptune, Uranus, Saturn, Jupiter and Mars before it reaches the *Earth*, and will have its path changed more or less by any and every planet which it may pass near to; and as those atoms and masses are passing sunward in vast numbers, and at greater or less distances from the planet, their paths will intersect and cross each other at a distance, as shown in the figure.



It is not possible to represent sizes and distances correctly in a figure, but it is easy to see if cosmic particles came into the system in the direction of the parallel lines and passed on each side of the planet B, they would cross and fall on an inner planet at C in greater numbers than at other points. If we suppose B to represent Jupiter and C the Earth, the earth would receive more meteoric matter when it was passing through this focus than before it reached it, or after it had passed through it. All the outer planets would act in the same manner on incoming matter, and this matter comes from all directions. Some will move *direct* and others *retrograde*; large numbers moving in opposite directions will collide, destroy each others' motion of translation, and fall on the planet within whose sphere of influence they may be at that time.

The great mass of the planets Jupiter and Saturn will probably cause them to be the disturbers of incoming matter, and we may consider them to be so situated as to act most powerfully to produce changes. They will shift their position in relation to each other constantly, and as Jupiter's period is 12 years and Saturn's 30, they will not be in the same position in relation to each other, and their position in the zodiac, for two revolutions of Saturn and five of Jupiter or 60 years, $12 \times 5 = 60$. So we have two cycles, one produced by Jupiter of 12 years, the other by Saturn of 30; and a cycle of 60 when both will act together. These may be causes of weather. Can we trace or find such cycles in our meteorological record?

Here is the rainfall record at the Toronto Observatory.

Sixty years ago Saturn and Jupiter occupied nearly the same position which they do this year (1902); we had a sun spot minimum in 1843 and a great rainfall, 43.55, and our average is only about 26.

Starting from 1843 as our zero year, we find a 12 year cycle fairly marked by

rainfall, and this cycle ends in 1903. $60 + 1843 = 1903$ which (if the theory is correct) should give us a plus from the Jupiter cycle. And again, two revolutions of Saturn starting at the same time also, end in 1903; so from this theory we should get 43 inches of rain next year. But all the other planets must have an influence of like kind; and to follow all the changes is beyond my power, and I give it up; but I still think that it will be done by some future meteorologists, and I wish our Mr. Stupart and other workers ultimate success.

NOTE TO PAGE 117.—This was observed by Dr. Massena at Itataya, Brazil, Aug. 7th, 1868. See Sci. Am., Oct. 28th, 1868.

THE PLEIADES IN LEGENDS, GREEK DRAMA AND ORIENTATION. BY J. C.
HAMILTON, M.A., LL.B.

(Read 5th April, 1902.)

Mr. Hamilton showed that the Seven Stars, by their gentle rays, impressed their image on the scroll of humanity in all ages. They were the clock stars of old astronomers, the guides of the mariner in his voyaging, and the husbandman in his seasons. The cluster was a familiar object in early British days. "Ye Old Seven Stars" is an inn in Manchester, whose license dates back to the reign of Edward III., in 1356, and the time of Chaucer. Guy Fawkes was here a visitor. Clubs of literary and social character took their names from the Pleiades.

The Seven Wise Men of Greece included Solon and Thales, the astronomer. Ptolemy Philadelphus had a Pleiad of Tragic Poets. Charlemagne formed a similar literary party, himself being one. Henry III. of France had his Great Pleiade, and Louis XIII. followed the example. In New England, there was a Pleiad of Yale poets, including Timothy Dwight and other ante-revolutionary men of learning. All poets have found them fit subjects for their muse. In "Locksley Hall," their rising is beautifully described. Wordsworth speaks of them, in his poem "Peter Bell:"

"The Pleiads that appear to kiss
Each other in the vast abyss,
With joy, I sail among them."

The cluster was affectionately regarded in Germany, Servia and Spain.

In the famous adventures of Don Quixote, that knight and Sancho Panza were made to pass the place where the "Little Nanny Goats," as they were called, were kept, and Sancho describes them inimitably. Thus the Spanish peasantry style these far-away, twinkling orbs.

Allusion was made to the customs in India, in reference to the measure of time and observing of feasts in honour of these stars. So, also, in China, where they are the Seven Sisters of Industry.

American legends as to them were discussed at length. They were also prominent in the religious ritual of the Aztecs and their successors in Mexico. In Peru, they were the gods of rain, and the year was counted, not by the sun but by them. The legends were very marked among the Blackfeet, Hydahs, Crees, Ojibways and Cherokees, of which interesting examples were given. While these are generally rudely drawn tales, inherited often from Asiatic ancestry, they have features in common; the persons represented are always seven, of whom one is lost or otherwise disappears.

The Blackfeet have a zodiac of 29 constellations.

Mr. Hamilton then discussed the beautiful references to these stars in the Agamemnon of Aeschylus, and the Iphigenia and other dramas of Euripides.

In the building of temples and other public structures, reference was, by the Egyptians, Greeks and other ancient people, made to a particular star at its rising or setting. Such star was used as a clock, its light being made to fall into the temple an hour before sunrise, that time being fixed for the morning sacrifice. Among temples oriented to Alcyone, chief star of the Pleiades, were that of Minerva, at Athens, 1530 B.C.; the temple built in 1150 B.C., on the site afterwards occupied by the Parthenon; that of Bacchus, at Athens, and several others. The Jews avoided this custom as heathenish. The Temple of Solomon and the Tabernacle were so designed as to cause the worshippers to face west.

Ezekiel VIII., 16, refers, with abhorrence, to a place where worshippers faced the east and worshipped the sun. This was 500 years B.C.

The description of the Great Pyramid, as given by the late Professor Piazzi Smith in his book, "Our Inheritance in the Great Pyramid," edition of 1880, was referred to, who declares that the Pleiades were there, as also in old Mexican temples, specially honoured; but it was shown that later writers, such as Gerald Massey, dispute much of this theory.

Mr. Massey, so, also, comes into conflict with the theories expressed by Ernest de Bunsen and R. G. Haliburton, and limits the cult of the Pleiades very much to Greece and Rome and the races sprung from them.

The late work of Sir N. Lockyer and Dr. Penrose, F.R.S., in orienting Stonehenge on Salisbury Plain was lastly discussed.

They show that there was here a great Temple of Apollo, after the Grecian or Egyptian model, oriented to the Sun, and declare that it was erected about 1680 B.C., or 500 years before the fall of Troy, by people who were not ignorant of astronomy, and whose priests knew more of the arts than they are generally credited with.

Stonehenge was assumed to be the place referred to in Diodorus Siculus II., 47, as a sacred enclosure dedicated to the Sun-God, and by Caesar, de Bello Gal. VI., where he stated that its Druid priests taught of the movements of the stars, the size of the world, the nature of things and the power of the immortal gods.

Mr. Hamilton referred to certain legends connecting Stonehenge with the Pleiades.

THE CAUSE OF THE ACCUMULATION OF MAGNETIC STORMS WHEN THE EARTH IS NEAR
THE EQUINOXES. BY ANDREW ELVINS.

(Read 7th February, 1903.)

IN a paper read before this Institute about a year ago on sun-spots and the phenomena which seem to be connected with them, I expressed the idea that sun-spots, auroræ, and magnetic storms are caused by matter forming in space, and passing sunward in orbits more or less elliptical, which, when they cross the earth's orbit, produce auroræ and magnetic storms, pass on sunward, and by planetary perturbations and collisions fall in part on the sun and produce solar-disturbances. Supposing the theory then advanced to be correct, I wish to show how it is the fact that magnetic disturbances are *more numerous* at times when the earth is near the equinoxes than at other times.

The fact that disturbances are more numerous when the earth is at the equinoctial points, than at other parts of its orbit, shows it to be in some way connected with the earth's annual revolution.

Let us look for a moment at this motion. The sun is at the centre of the path in which the earth moves. We call the plane in which the earth moves the plane of the ecliptic. Whilst the earth is making its annual revolution, it is also rotating on its axis, and this axis is not at right angles to the plane of the ecliptic but about 24° from it.



If the poles were at right angles to the plane of the earth's path, each of the poles would be equally exposed to matter coming sunward from without in each month in the year (and as the planets move near this plane, and reach outward into space, *their action* on incoming cosmic matter will cause the larger part of it to move in this plane also; cosmic matter will be more abundant near the ecliptic than elsewhere); the earth in passing through it will have one pole more exposed to this matter during one half of its orbit, and the other pole most exposed during the other half. But at the equinoxes both poles will be equally exposed, and at any given point, except, perhaps, near the equator, the plus of cosmic matter which produces magnetic disturbances will fall on the outside hemisphere of the earth when it is near the equinoxes.

On this theory cosmic matter passing by the earth going sunward is the cause of *auroras* and *magnetic disturbances*; the plus of such matter caused by the action of Jupiter and Saturn, on incoming cosmic matter, is encountered by the earth when it passes us going sunward, and this is the cause of the long 11-year period. The moon's revolution, combined with the earth's motion, is the cause of the 25-day period, and the inclination of the earth's axis is the cause of the *plus of disturbances at the equinoxes*.

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THE PLEIADES AS THE HESPERIDES, ISLE OF THE BLEST, OR PLACE OF FUTURE
BLISS. BY J. CLELAND HAMILTON, M.A., LL.B.

(Read 14th November, 1903.)

MR. HAMILTON referred to Dr. Wallace's theory, that the solar system is the centre of the universe, as controverting both scientific and classical notions, and not yet at least generally held. He then took up in detail legends of many nations which pointed to the stars of the Pleiad group as the resting place of their ancestors' spirits and their own heaven. Such were the Arabs, the Berbers of North Africa, and Dyaks of Borneo. The British Druids had an ancient mythology drawn from the same source as that of the Greeks, had gods of characters similar to Pluto, Mercury and Zeus, and, in strange metaphoric poems, referred to the Pleiades. Their midnight ceremonies in the autumn, at the time of our Hallow-e'en, commemorated the season when the Seven Stars were highest in the visible firmament.

The lecturer discussed legends of the Adipones, the Hurons, Iroquois, Black-feet and other native American races, which made their heaven where the sun sets. Hiawatha's departure to the west in his birch canoe was compared to that of King Arthur in the Druid legend, the basis of Tennyson's "Mort d'Arthur." "The White Stone Canoe," an Ojibway legend translated into Hiawathan metre, by the late Sir James D. Edgar, represents the young brave Abeka, seeking his lost love, Wabose, in the redman's spirit land, where he finds her on a beautiful happy island, and here is repeated the Greek legend of the "Isle of the Blest" with a Promethean moral. Such beliefs were found also among the Hydahs, Eskimos, Chippewayans, Salish, Chiwaks, and, throughout the continent, to California. The curious myths of the Polynesians were referred to, and examples given of many strange coincidences with the legends of Egypt and Phoenicia, and paralleling those as to Atlas, Hercules, Pluto and other deities of Greece. They had, too, an "Isle of the Blest," but knew only six Pleiades, which they called "Matariki"—"Little Eyes," or "Tau Ono," The Six. They were objects of worship in these islands until the introduction of Christianity in 1857.

The ideas of the Hindus, Chinese and other Eastern people as to the place of the future were reviewed. The different views expressed by Homer, Hesiod, Lucian, Pindar and Plato were discussed. There were depicted beautiful plains without winter, fear or pain, where fruit of every kind abounded and joys never ceased. They were placed in the West, where the sun goes down, in a happy isle, where gentle sea breezes blow. Plato taught that only those enjoyed such bliss who had spent life in holy philosophical pursuits, useful to their fellow-men. He placed this pure abode in "the upper parts of the earth in places not easy to describe." The conception of the Hurons, Iroquois and Algonquins as to this place of bliss, is described by Colonel Garrick Mallory and Dr. A. F. Chamberlain, the archaeologists, and by the historians, Bancroft and Schoolcraft, in very similar expressions. The essayist quoted several beautiful Greek epitaphs in which such ideas are embodied along with hope of future meeting. He then explained the theory which assigned Alcyone, the chief star of the Pleiades, to the position practically of the centre of the universe and the place of future bliss. This great star was often so regarded and called "the central one" and "the leading one." However much appears to sustain such theory in classic story and in legends of uncivilized tribes, it was admitted that such claim is not as yet supported by science.

The lecturer concluded his discourse, stating that these many widespread traditions furnish a mass of evidence in favour of a common origin of mankind and of the existence of a general belief in life hereafter, where those who had here lived worthily would meet their ancestors and friends in a beautiful happy place somewhere, either on an island in a western ocean or in the most favoured of the great orbs, which, to use Shelley's words, form "Heaven's constellated wilderness."

INTERIOR THERAPY : A CASE OF LEAF-CURL. BY ARTHUR HARVEY, ESQ.

(Read 21st November, 1903.)

I HAVE always had trouble with peach-trees owing to their liability to "leaf-curl." I am not aware that it is annoying to larger growers, or on other than clay land. But in Rosedale I have found more than half my trees affected by it. It is destructive to the crop. I suppose it to be a bacterial disease.

As soon as the leaves are an inch or two long, their substance thickens about and around the point attacked, the swelling soon deforms them, a sort of knot is formed, they curl, turn red and yellow in places, and as most of the leaves are thus affected, the branches look as if blasted by some irritant poison. If left to themselves, the diseased leaves will fall off, others will grow further up the shoots, but even they are liable to be affected, though not to the same extent. If picked off, which with small trees I have tried to do completely, the same result follows; the disease is not conquered even by two years of such drastic treatment. Some trees have this "leaf curl" worse than others, some are quite immune.

Last year a fine Elberta in my garden was beginning to blossom, and it suffered so much that I would have cut it down had I not wished to attempt a cure. This spring, as soon as the evil began to show itself, I bored a gimblet hole in one of the branches, at an angle of 45° with the horizontal. Into this I fitted a quill, and kept the quill full of a saturated solution of copperas. The tree absorbed a quillful in about six hours. In a day, I could see that the leaves in the upper part of the branch were affected, and those which wilted in this manner soon died, and no further vegetation took place to supply the want of them. I soon perceived that the copperas had not been diffused to any appreciable extent, for the injury went along one only of the branches springing from that which was under treatment, and only one of the final tufts of leaves was killed. The particular fibres cut by the gimblet had soaked up the solution, which did not extend to others but only to their own continuations. This, I believe, puts an end to all hope of success in the particular direction attempted. A weaker solution, or one of a different kind, would in like manner affect a few fibres only and their ramifications.

In the fall there was a line of spots, exuding gum, along the whole of the affected fibres, not elsewhere, except that below the boring there were also a few, due to the death of the fibre leading upwards from the root, from want of exercise. Not having any connecting tubes, it got choked. The rest of the tree was not affected by the copperas, it suffered as usual from "leaf curl," and I shall cut it down next spring.

I may say that washing the bark with lye or the usual poisons has no palliative effect, in my experience.

AURORAL PHENOMENA, SUN-SPOTS AND MAGNETISM. BY ARTHUR HARVEY.

(Read 28th November, 1903.)

MR. ANDREW ELVINS having stated in a recent paper that magnetic storms were more frequent at the equinoxes than at other seasons, I have prepared a diagram to show the times at which such storms have occurred since 1881. Were it not for the encumbrance to distinctness I would have gone back fifty instead of twenty years. There is no greater frequency at the equinox. The points mark the depressions in the curve of magnetic Horizontal Force at Toronto, and indicate not only the dates of magnetic storms but their relative intensity.

Mr. Elvins produced a statement from the *Washington Weather Review* that Tromholt's auroral catalogue showed some excess of auroræ at the equinoxes. I was aware and had myself stated when Mr. Elvins read his paper that there had been a slight excess of magnetic tremors noticed about the equinoxes by the United States observers at Los Angeles—and to see if this were really reflected by a slight excess of auroræ, I made a study of the interesting catalogue of Norwegian auroræ, the life-work of the late Dr. Sophus Tromholt, of Christiania, edited by Prof. I. F. Schroter, of the Observatory there, at the joint cost of the Scientific Association of that city and the Fridtjof Nansen Fund. I found a very slight excess of auroræ observed in March and September, but it was accounted for by quite other reasons than Mr. Elvins supposed, namely, by climatic obstacles to observation in the most northerly regions of the Scandinavian peninsula, where for nearly half the year people do as little outside observation as possible, and during most of the other half, twilight or actual sunlight renders auroræ invisible. It is plain that about the equinoxes the conditions for observation are more favourable, and the wonder is, not that there should be a trifling excess observed, but that the excess should be so very small.

There were, however, other things of interest to be gathered from Tromholt, some of which are to be alluded to in the present paper, which is intended to be a new historical proof that auroræ are especially prevalent during years of solar activity, and that their numbers and brightness correspond accurately therewith: also to illustrate the changed position of observers of such meteoric phenomena in that superstitions regarding them are fading; and lastly to touch on some instances of the wide extension of remarkable auroral displays.

The earliest allusion to Scandinavian auroræ is that in Tacitus ("Germania," chapter xlv.): "On the farther side of Swedes-land is another sea, dark and almost motionless, which is thought to girdle and enclose the terrestrial orb, because there the last light of the setting sun endures until its rising again, so brightly that it dims the stars. Moreover it is credibly reported that sounds are heard there and the shapes of gods seen, with radiance around their heads." Pliny puts us on the track of earlier auroræ when he says ("Natural History," Book I., chapter xxvii.): "There is a flame of a bloody appearance, and nothing is more dreaded by mortals, which falls down upon the earth, such as that seen . . . when King Philip was disturbing Greece." Also that "a bright light has been seen issuing from the heavens in the night time, so that there has been a sort of daylight at night, as was the case in the consulship of L. Valerius and Cn. Papirius." The date of L. Valerius was 462 B.C., when the Romans were having a troublesome war with the Æqui, and, says Livy, "the heavens were seen to be on fire with a very great flame," so a three days' penitential ceremony was ordered, during which crowds of men and women thronged the temples, begging the angry gods to stay their hand. Three years later the sky was seen on fire again, there was an earthquake, and a bull was heard to speak. The King Philip trouble was about 200 B.C. (Livy xxi., cap. 12) when again the heavens were aflame, and the priesthood saw their opportunity for interpreting the natural phenomenon in their peculiar way,

Sun-Spot Relative Nos.

Observed numbers

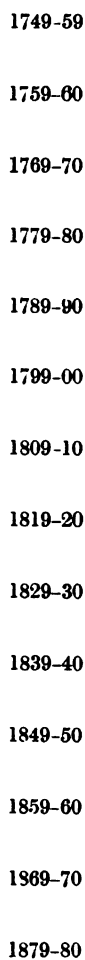
Smoothed numbers

TROMHOLT-SCHRÖTER.

Scandinavian Aurora 1749 to 1874-5.

Observed numbers

Smoothed numbers



Tany.

Feb'y.

March

April

may

www

[illegible]

MAGNETIC STORMS SINCE 1881. FIRST HALF OF THE YEAR. THERE IS NO EXCESS AT THE EQUINOX.

Tuesday

August

Sept.

October

November

December

MAGNETIC STORMS SINCE 1880. LAST HALF OF THE YEAR. THERE IS NO EXCESS AT THE EQUINOX.

as they had done for thousands of years before, and occasionally persist in doing still. But, coming to Tromholt, we read that in A.D. 1550 the "common people" thought the lights were "a reflection from the schools of herrings which assembled about the beginning of autumn, and, by turning hither and thither, and leaping up and down, threw such a light upon the clouds that the heavens flared up." He transcribes several curious accounts, as of "a glowing sword which thrice smote the earth and swiftly rose again," and of "a black cloud in the north-west with a long neck and a head with a Russian hat and plumes." This was met by another with a Mecklenburg hat, and a third with a Royal Crown, and "one could see that the one with the hat had a long pointed beard and a crooked nose." Next there came "a tremendous big bear which opened its mouth wider and wider and spewed fire, steam and smoke high into the sky. . . . What all this is to betoken is all in the hands of the Lord." There is a case where "a long neck grew from a cloud which became like a living camel, and against it came a fearful beast, which was most like a dragon, with a long, crooked tail." When the dragon attacked the camel, this beast opened its jaws, swallowed the greater part of the dragon, and both vanished. This display does not bear the marks of an aurora so clearly as the other accounts, but it shows how supremely fitting it was for Shakespeare to put into the mouth of a Prince of Denmark the familiar words—

Hamlet—Do you see yonder cloud that's almost in shape like a camel?

Polonius—By the way, and 'tis like a camel, indeed.

Hamlet—Methinks it is like a weasel.

Polonius—It is backed like a weasel.

Hamlet—Or like a whale.

Polonius—Very like a whale.

But we need not go to the Baltic or the Mediterranean for accounts of the superstitious fears with which people once looked on the lovely phosphorescence of the auroræ. Here is a pen picture by the Rev. James Harvey, a Northamptonshire rector, whose "*Meditations Among the Tombs*" were once classical, who was a fair astronomer, and wrote "*Contemplations on the Starry Heavens*":—

"Sometimes, at this hour, another most remarkable sight amuses the curious and alarms the vulgar. A blaze of lambent meteors is kindled, or some very extraordinary lights are refracted, in the quarters of the north. The streams of radiance, like legions rushing to the engagement, meet and mingle, insomuch that the air seems to be all conflicting fire. Within a while they start from one another; and, like legions in precipitate flight, sweep, each a separate way, through the firmament. Now they are quiescent: anon they are thrown into a quivering motion; presently the whole horizon is illuminated with the glancing flames. Sometimes, with an aspect awfully ludicrous, they represent extravagant and antic vagaries, at other times you would suspect that some invisible hand was playing off the dumb artillery of the skies, and by a strange expedient, giving us the flash without the roar.

"The villagers gaze at the spectacle, first with wonder, then with horror. A gruesome panic seizes the country. Every heart throbs and every face is pale. The crowds that flock together, instead of diminishing, increase the dread. They catch contagion from each other's looks and words; while fear is in every eye and every tongue speaks the language of terror. Some see hideous shapes, armies mixing in fierce encounter, or fields swimming with blood. Some foresee direful events: states overthrown, or mighty monarchs tottering on their thrones. Others, scared with still more frightful apprehensions, think of nothing but the day of doom. 'Sure,' says one, 'the unalterable bow is struck and the end of all things come.' 'See,' says another, 'how the blasted stars look wan! Are not these the signs of the Son of Man coming in the clouds of heaven?' 'Jesus, prepare us,' cries a third, and lifts up his eyes in devotion, 'for the archangel's trump and the great tribunal.'

Nor is it needful to leave our own country to find such examples: we have them in the letters of the Jesuits from Canada. Father Biard writes from Port Royal, now Annapolis, N.S., January 31st, 1612:—

"The stars had already begun to appear when suddenly, towards the north-west, a part of the heavens became blood red, and the light, spreading little by little, in spear and spindle-shaped beams, shifted until it was over the settlement of the men from St. Malo, tinging the whole river and making it luminous. It lasted about eight minutes, then disappeared, when the same programme was repeated. Our Indians cried out, 'Gara gara, endirquar, gara gara,' that is, we shall have war, such signs denote war. Nevertheless . . . during the day there was nothing but friendliness. But at even everything went contrariwise—confusion, quarrels, rage, uproar between our savages and the people from St. Malo. I do not doubt that a cursed band of furious and sanguinary spirits were fluttering about us all that night, expecting every hour and moment a horrible massacre of the few Christians who were there, but the goodness of God restrained them, the wretches."

A similar meteor in 1616, when also the sky became wonderfully red, was greeted by the Indians with the exclamation, "Gara gara, maredo." War, war,

there will be blood. A hundred and twenty years later, in 1736, familiarity had deprived auroral phenomena of their terrors, and Father Aulneau, writing from Fort St. Charles, among the Crees, near the north-west angle of the Lake of the Woods, merely says:—

"I have noticed on several occasions, especially while on Lake Huron, grand displays of the aurora borealis . . . scarcely a night has passed but the northern skies have been all aglow with it."

It is improbable that many of us, who have seen some auroral glories, or at least read about them, would be given over to such abject folly as our forefathers, but to populations who take literally the imagery of the Sacred Book of Revelations and look for the actual, physical happening of the poetical prophecies of its author, who beheld the heaven depart as a scroll when it is rolled together, and heard angels sound on trumpets signals for hail mingled with blood to fall upon the earth, and for a great star to fall from heaven, blazing as it were a lamp, and who saw other spirits pour out vials upon the earth, and the sea, and the streams, and the sun, and the air, when there was a great earthquake, and the cities of the nations fell, and every island fled away and the mountains were not found—to such, I say, the sky, luridly red behind light drifting clouds, may cause mortal fear, and so may the fiery arch with flaming coruscations, slowly moving to and past the zenith. Nothing dissipates such terrors more efficiently than travel and scientific study, which are necessary to the growth of civilization, as foreseen by another prophet, Daniel, who said that "many shall run to and fro and knowledge be increased." The car of Science is as merciless as that of Juggernaut. It leaves as victims behind it not the bleeding corpses of votaries, but the lesser miracles, which it destroys one after another, leaving glorified the one great miracle of all, the wonderful order of nature, the living world, which is dying daily but daily being resurrected in obedience to the law of its being. With the six literal days of creation vanishes also the one single day of judgment, and the sudden end of things, and we shall ere long hear that the one has no more Divine warrant than the other. But while there still exists a lingering faith that heavenly displays are signs and portents, science may be charitable to those who look at them in the spirit of Bernard of Morlaix, who was perhaps dreaming of a northern aurora when he wrote of the *bona patria* in his wave-crested dactyls—

"Est tibi consita laurus, et insita cedrus hyssopo :
Sunt radiantia jaspide moenia, clara pyropo.
Hinc tibi sardius, inde topazius, hinc amethystus
Est tua fabrica concio cœlica gemmaque Christus."

Every one now knows that the aurora is a manifestation of terrestrial magnetism and that both are intimately related to solar activity. But we can estimate the rapid progress of modern science and the length of its recent travels along the pathway of solar radiations by reflecting that some of us, in this very hall, have heard that as there could be no action at a distance without a medium, no electrical energy could be transmitted from the sun to the other bodies in his system. Nobody denies, to-day, that there is a medium we have agreed to call the ether, whose qualities we are beginning to comprehend, nor is there any further denial of a direct rectilinear radiation of energy from the sun. The proof of this action of the sun upon other bodies was given in our semi-centennial volume of "Transactions," page 345. Another step was taken here and noticed at page 107 of our "Proceedings" for 1901, where the synchronism of auroræ australes and boreales was shown, which entitles auroræ to be classed among cosmical events. The bold theory of Dr. Gilbert, one of Queen Elizabeth's physicians, that the Earth is a great magnet, though scouted by Bacon, as was the Copernican system, too, and though it slumbered from its birth to the times of Faraday, has now taken on a new beauty. We can picture to ourselves the round world receiving its electrons or whatever carries or transmits energy through a material ether from the distant sun, and lighting up at night with coruscations about either pole, as this distribution from the cathodic source occurs.* The comparative figures are given in the annexed table. The Antarctic Auroræ are those observed by Mr. Henry N. Arctowski, in the "Belgica."

* The auroral beams seem to emanate from the edge of an irregular elliptical region, which includes both the strong Canadian magnetic pole and the weaker one in Siberia. Thus, by going north, one gets into parts

1898.	MARCH.			APRIL.			MAY.			JUNE.			JULY.			AUG.			SEPT.			1898.
	A	C	W	A	C	W	A	C	W	A	C	W	A	C	W	A	C	W	A	C	W	
1					2	2	4	2					*			4			1	1		1
2						2		1					*	1	1		4	1	45	19	50	2
3				4	3	1	20	7					*	5			2	1		4	3	3
4						2		6						1			1			1		4
5						*								3	1		3		5		1	5
6				14	4	1		2	*	9	2			9	0		1			2	2	6
7					1	1		2	1	1	3									1		7
8					1	2		2	1				4	1	1	*			4	4	5	8
9					17	1	*	5	3	2			4		3				25	36	52	9
10	*	2		17	20	3		3	2	5	2	1	4		2		1	1	25	32	28	10
11	5	6	4	4	16	5	*	5	3			2	4									11
12	5	5	2	4	59	32	*	2		1	2	4	5		*	9	7					12
13		2	30	4	16	13		3		26	4	1	21	4	1		4	3				13
14	15	109	289	50	25	23				4	4	4			2		1					14
15		96	252	25	20	7		3	3	4	2	1	4			*	10					15
16	*	8	27		7		4	4							3	4	16	8				16
17		1	3		8	1		1		1		1	4	2			17	3				17
18	*	10	6	*	8	1				1				2	2	4	3	3				18
19	22	20	17	*	11			2	1	*	2	1		12	11	12	7	5				19
20	28	11	4		6	2	11	2	1		1		*	18	5	4						20
21		13	4	4	1		4			4	1	15	20	10								21
22	*	10	7	9	4		4			19	32	6	11	18	4		5	3				22
23	4				2	2				10	8		5	2	1	*		1				23
24	4	5	3	4	7		1	1		12	3		4	8			4	1				24
25	11	7	1	19	2	1				5	4		6		*			1				25
26	38	10	2		2	2		2					1		5	11	1					26
27	4	4	1	*	6	2		5	1	*	2	1		3	1	5	2	1				27
28	4	1	3	4	3		*		2		2	1		3	2			1				28
29	4	14	5		1	2	6	17	3		4	4					1					29
30		4	1		4	1		7	3					2	1			2				30
31	5	4	3					1							4							31

A—Antarctic Observations. Arctowski.

C—Canadian Weather Service Observations.

W—United States Weather Bureau Records.

*—Cloudy all day and night, usually preventing even glimpses of clear sky.

The Antarctic Observations are weighted according to the features reported; the Canadian in the ratio of number and brightness; the American Weather Bureau gives numbers only.

Tromholt gives Norwegian Observations only, but the editor has wisely added the Swedish records collected by Rubenson. The curve from the first is much less instructive than that made from the two sets of figures combined, and the latter is the one I present for examination. I contrast it with the sun-spot curve made from the figures of Professor A. Wolfer, of Zurich.

The auroral year begins with July 1st of one calendar year and runs to June 30th of the next. The difference with the sun-spot year, which follows the calendar, has been duly allowed for in the diagram.

A sun-spot maximum, in 1761, had just passed when these observations were begun. Including it, twelve maxima and as many minima are indicated, echoed by the same number of auroral maxima and minima. The gradients of the two curves are generally alike, and would probably be more so if we could add contemporaneous records from other regions and so mark the irregularities due to

where auroræ are seen to originate to the southward. The "Century Magazine" for February (1903) has a description of one seen March 16th, 1898, a day on which the skies were continuously clouded for Arctowski, in the Antarctic, and no aurora could be seen. At Point Barrow (lat. $71^{\circ} 17' N.$, long. $146^{\circ} 40' W.$) Mr. E. A. McIlhenny was "watching a number of Esquimaux playing football. Suddenly they stopped and began to whistle. On being asked why, they pointed to a small bright spot near the south-eastern horizon, and said they were calling the aurora, a marvellous display of which immediately ensued. From the spot in the south-east there shot up a ray of bright rosy light, etc., etc." Mr. F. W. Stokes has an article on the aurora in the same "Century," and he was north of the ellipse in lat. $64^{\circ} 10' N.$, long. $55^{\circ} W.$, for he writes that when he was called on deck by exclamations of enthusiasm, "a faint film had arisen at a point low on the south-eastern horizon. Then, silently and swiftly, a curtain of light arose," and Mr. Stokes' vivid sense of colour and form enabled him to perceive that in the north "great nature's palette was set with more varied riches than elsewhere."

cloudy weather, moonlight nights and the different lengths of daylight in summer and winter. But the differences are noticeable too, and afford another proof of the statement I ventured to make last session that the extent of spotted areas on the sun is not an exact measure of solar activity. Counting the same spot over and over again, day after day, as it persists, is in my judgment erroneous, being a duplication and reduplication of the credit entry in the solar ledger, whereas the magnets on the earth rarely show continuing storms for more than a couple of days. The auroral curve corresponds more closely to the magnetic curve than to the one showing the spotted areas on the sun.

Professor Wolfer, on being informed of this view, which implies that the special solar energy concerned in the production of a sun-spot does not last throughout its visibility, but is greatest at the outbursting of the spot and during its active growth, and diminishes with the decay of the spot, replied that he believed the force which caused the spot continued until its extinction, but later letters show less confidence in that theory. The general question of sun-activity is of the greatest interest and importance.

Galileo and Scheiner were the first observers of sun-spots early in the seventeenth century, but it was not until the middle of the nineteenth that Schwabe discovered their recurrent frequency in what is known as their eleven year period. The systematic observation of faculæ comes quite within our own times, as does that of prominences, which, indeed, could only be recorded after one of the most wonderful of the many applications of the spectroscope had enabled us to see them as they come on or pass off the sun's limb or edge. These three forms of solar activity are necessarily related, that is, while the spots are at a maximum, there are more faculæ and prominences, but the precise times do not correspond. So magnetic energy on the earth follows very closely the sun-spot curve, and, as might be expected, auroral frequency does the same. But, as compared with sun-spots, magnetic storms tend to "lag." The principal magnetic disturbance is usually a few hours after the centrality of the spot region from which the excess over the daily issue of radiations issues, sometimes even a day or two. Also, curious to note, these Tromholt auroral curves show a usual "lag" of months between the auroral and the sun-spot manifestations. The figures work out, by my calculation, as follows:—

MAXIMA.		MINIMA.	
By Sun-spots.	By Auroræ.	By Sun-spots.	By Auroræ.
1750.3	1749.0	1755.2	1755.5
1761.5	1761.7	1766.5	1766.0
1769.7	1769.7	1775.5	1776.0
1778.4	1779.1	1784.7	1784.0
1788.1	1788.3	1798.3	1799.0
1805.2	1805.7	1810.6	1811.0
1816.4	1817.3	1823.3	1823.5
1829.9	1830.7	1833.9	1834.5
1837.2	1839.0	1843.5	1845.5
1848.1	1849.0	1856.0	1856.0
1860.1	1862.0	1867.2	1867.0
1870.6	1870.6	1878.9	1879.0
Average lag, .55 of a year.		Average lag, .24 of a year.	

The determination of the auroral maxima and minima to the fraction of a year is not so precise as that of sun-spots has become, owing to the lack of observations in both hemispheres and all around the earth. We see no auroræ in the far north in May, June, July and August, and have as yet no reliable means of rectifying the irregularity by observations in the far south.

We see in the Tromholt curve, and it is not unimportant to observe, that the wave between the principal auroral maxima appears to embrace two spot maxima. Thus, the great curves from 1755 to 1776, and from 1776 to 1779, seem each to be one wave of influence having two impulses about eleven years apart. So also the quiet time from 1799 to 1823.5 seems one period, while from 1823.5 to 1845.5 is evidently one wave of twenty years length. While from 1845.5 to 1856 is a shorter vibration, it is manifest that from 1856 to 1879 we have the double period again. I have not yet been able with the data at control to prolong the Schroter tables to the present date, for the auroral data on this side of the Atlantic, which are being

fairly well collected now, were in an imperfect state from 1878 for several years. It is, however, fairly clear that the Tromholt tables give but slight countenance to Sir Norman Lockyer's 35-year period between important minima. It appears between 1776 and 1811, and perhaps between 1811 and 1845.5, but the only auroral minimum which could fit in before 1776 was in 1738, which is thirty-eight years before, and the one at this end of the series, following 1845.5, was in 1879, or 33.5 years apart. These divergences are too wide to base a law upon.

The solar prominences are now being sub-classified, I hope. The observations appear to be separating the common form of hydrogen prominence from the metallic prominences. While in our "Transactions" I have recorded my inability to detect magnetic effects consequent upon the former, which are by far the most frequent, I do find a connection with the latter. We are upon the eve of important solar discoveries, and another step in advance towards a knowledge of his constitution and the problem why the Geyser-like intermission of the eruptions upon his surface occurs. It will assuredly not be the sun's passage through matter floating in strata in space, which is an old theory Mr. Elvins has not yet chosen to abandon.

We can see by the Tromholt auroral curve, as well as by the spot curve placed in juxtaposition, what a shamefully irregular body the sun is, and how little dependence can be placed upon his ill-understood whims. Adverting now especially to spots, not only are the periods uneven, varying on the interval before us from 7.3 to 17.1 years between maxima, and from 9 to 13.6 years between minima, but the amounts of spottiness attained during his pulsations of energy vary, too, some maxima being three times as marked as others, that is, the spots cover three times as much solar area. Galileo had no trouble in seeing and drawing sun-spots in 1510-13, but his successors were less fortunate, for, as Miss Agnes E. Clerke tells us, a prolonged solar calm set in about 1643, and only a few solitary spots were seen in 1660, 1671, 1684, 1695 and 1705, which Professor Maunder happily calls "the crests of a sunken spot-curve." As to auroræ, the earliest Norwegian observer says: "When I was a child, about 1550, they were for the first time seen in the southern regions of our country, but since 1570 they have been rising so high that they can even be seen in places to the south-east and south of us, and I think they may now be viewed in other countries, too." It seems, however, rather astonishing to learn that no auroræ were seen in England from 1575 to 1706—a hundred and thirty-one years. From 1790 to 1815 there were very few seen in Norway, and not many for ten years more, after which they again became frequent. The correspondence between the recent solar minimum and the magnetic and auroral minima has not yet been thoroughly examined, but at Toronto the records show, on the magnetic traces, during the rather prolonged and very marked solar minimum, which reached its nadir in 1901.7, an almost continuous straight line. In Christiania, Milan and Prague, the least average variation in declination was in 1902, another "lag" as compared with the spot minimum, and the same feature may be evidenced when the Toronto records are digested. The auroræ observed here in 1901 and in 1902 were equal, but less than in any year since 1878. In this year, 1903, sun-spot activity is markedly revived, also magnetic variations, earth currents and auroræ.

As to the cause of auroral light, the new theory of corpuscles seems to apply—particles shot off from the sun being constrained to move in spiral pulses along the lines of magnetic force as they approach the earth's surface. As they move from the upper regions of the air towards the poles they go through air strata so rarefied that luminosity can be easily excited (as when an electric current passes through a nearly exhausted receiver), but as they approach the earth the density of the air forbids their luminescence. So far the theorists, and perhaps we had better for the present suspend judgment. The rapidity of the motion of electricity would scarcely allow the eye to follow it, as it does in the case of the aurora, even at the ascertained height of auroral displays here, say 100 miles. We should see something resembling the lighting's flash for swiftness. Possibly the radiations which convey electrical charges from sun to usward move more slowly than those we feel as light, which might account for the peculiar "lag" of magnetic effects.

The localization of auroral effects is also very strange. The same aurora is seen differently in different regions. This was made curiously evident in examin-

ing the remarkable aurora of September 2nd, 1898, at the request of Mr. Arctowski, who described it as he saw it in Belgica Straits.

"At 7.50 a fine arch, large, exceptionally high. 8.00, a second arch forms within the first, becoming very intense. Color, green. Rapid movement of the rays from right to left. Fluctuations. Ribands. Snake-like undulations, curving back on themselves. Homogeneous light, white or yellowish, mingles with the rest. 9.30, intensity renewed. Above, a great arch, a single band, clearly defined below, shaded off above, with large waves. 10.15, inside the arch, now much disorganized, is a broad, intense band, bow-shaped, recurved, undulating in the upper part. 10.30, double arch, the outside one whiter than the yellowish but higher one inside. The interior arch bent upwards at one end and fringed with rays. 10.40, the auroral sheen is intense. All the details of the aurora are in a way effaced by a spontaneous effervescence of light. The whole segment is luminous. 10.50, fading, rays distinctly green, distributed all over the part of the sky where it has been, seeming to start from a series of different bands."

The weather in North America was fine and clear on that September 2nd, all over the latitudes where auroræ are to be looked for, except in the State of Maine and the adjoining Maritime Provinces. The observations available are 78, and they are thus distributed—

United States—Idaho, 1; North Dakota, 1; South Dakota, 1; Minnesota, 9; Iowa, 9; Wisconsin, 10; Illinois, 7; Michigan, 10; Indiana, 3; Ohio, 1; New York, 4; New Jersey, 1; West Virginia, 1; Maryland, 1.

Canada—North-West Territories, 5; South-West Peninsula of Ontario, 10; Muskoka and Northern, 4.

Thus the visibility of this aurora was localized in and just around the basin of the great lakes, with a secondary focus of excitation in the far west, on both sides of the boundary line.

Localization is to be noticed in the case, too, of the fine aurora of September 9th, 1898, also brilliant in both hemispheres. Arctowski tells of its "dark segments," "homogeneous arcs," "double arcs," and "rays," witnessed in extraordinary beauty in the Antarctic. Here we had 80 observations, the weather being clear all across the auroral belt of America, except in Nebraska and Iowa. There was a little patch of 16 observations in the North-Western States, and another of a dozen around Pembina and Quesnelle, some brilliant. Then there is a connecting belt of 7 sporadic observations between Winnipeg and Montreal, corresponding to those in Minnesota (4), Wisconsin (2), Illinois (1), and Michigan (1). A scattered single report comes from Kansas. And then comes the great outburst further east: Pennsylvania (3), New York (5), Rhode Island (1), Maryland (1), Vermont (2), Connecticut (2), Massachusetts (7), New Hampshire (10), Maine (5). In Quebec and around the Gulf of St. Lawrence (12), Maritime Provinces (6).

This aurora, then, had its chief American focus by the sea, and a secondary one two thousand miles to the west. It was particularly fine on the European side of the Atlantic.*

Eight descriptive accounts of the aurora of September 2nd have been sent to me from Washington. They are strikingly dissimilar, so much so that the discrepancies cannot arise from errors of observation. Thus, at Dubuque, Iowa, it is expressly said that no arch was visible, and none is mentioned from Duluth or Milwaukee, but there was an arch at Grand Haven, Green Bay, the Sault de Ste. Marie and Rochester, N. Y. At Milwaukee the aurora was highly coloured, green, yellow and yellowish green, at times a red tinge, the whole appearing to be covered with a silvery sheen. At Green Bay "the entire heavens would at times be illuminated with a variety of tints." At Duluth there were "well defined curtain folds and streamers beautifully coloured, constantly changing effects." On the other hand, at the Sault de Ste. Marie, while there was a fine arch and streamers reaching to the zenith, there were no colours noticed; at Grand Haven the arch only gave out faint streamers and no colours are mentioned. At Dubuque there was "a pale, diffuse light," no arch; slender, luminous beams of a pale yellow occasionally rose and suddenly disappeared. The account from Minneapolis differs from both the above classes. "About 9 p.m. two broad parallel bands of light were seen extending . . . across the sky. In the north-east the sky seemed somewhat overcast, and on the edges of what appeared to be clouds there were occasionally patches of bright light which came and went with some rapidity. Sometimes a suggestion of a vibratory motion, but the illuminations were all indistinct. Later in the evening the lights were much more brilliant, with curtain-like movements,

* Bulletin of the Astronomical Society of France, October, 1898.

dark segments, flickering motions, etc. It lasted until nearly midnight." This is the description which offers the closest analogy to Mr. Arctowski's aurora, except that at Minneapolis no colouring is mentioned. But such resemblances are evidently fortuitous. On September 9th the aurora seen on the *Belgica* was not reported from Minneapolis, but of that aurora, the writer has analyzed eight American reports. Their principal feature was the appearance and persistence of detached masses of auroral radiance, while nothing of the kind is mentioned by Mr. Arctowski. These accounts, too, differ widely among themselves. It will be in order, then, to examine the hygrometric conditions of the atmosphere attendant on these various kinds of display, for differences therein at various levels may cause the variations in the auroral effects of the same magnetic influence—the height of the streamers and their colouring.

Arctowski writes as follows :—

"Dans mes remarques, je n'ai insisté quelque peu que sur l'identité probable des distributions géographiques, par rapport au pôle magnétique, du phénomène auroral, et j'ai posé un point d'interrogation au sujet de toutes les autres analogies qui sans doute seront découvertes dans la suite. Mais voilà que M. Harvey vient de nous démontrer une remarquable concordance entre les aurores observées en 1898 au Canada et dans le Nord des Etats Unis et celles que j'ai notées dans l'Antarctique."

He further says :—

"Mr. Arthur Harvey ayant sous la main des documents beaucoup plus importants que ceux dont je dispose, je ne puis que l'inviter d'étudier, au point de vue auquel il est placé, les observations que la Commission de la *Belgica* publiera sous peu."

He formulated several questions which we can now answer—

Q.—Was the duration of the auroræ of September 2nd and 9th, 1898, the same in the Northern United States and Canada as at the station of the *Belgica*?

Ans.—At the points where the auroræ were best noticeable, the duration was about the same, but was not alike at all places.

Q.—Were the fluctuations of intensity the same, north and south?

Ans.—They differed among themselves here, in this particular also.

Q.—Do the maxima and minima correspond, to the moment?

Ans.—No, these too differ here.

Q.—Are the heights to which the auroral arch rises the same, at homologous points, i.e., at points equi-distant from the magnetic pole and on the same magnetic meridian?

Ans.—All we can say is that so far as our observations go, the higher the latitude, the higher the arch and its streamers rise. We cannot say which of the places at which we have observers is to be considered most homologous to that of the *Belgica* with respect to the magnetic pole. The positions are as follows :—

N. magnetic pole lat., $70^{\circ} 30' N.$; long., $97^{\circ} W.$

S. magnetic pole lat., $73^{\circ} 39' S.$; long., $146^{\circ} 15' E.$

Toronto lat., $43^{\circ} 39' N.$; long., $79^{\circ} 24' W.$

Belgica lat. (September 2nd, 1898), $70^{\circ} 00' S.$; long., $82^{\circ} 45' W.$

Thus Toronto is 1,950 miles from the north magnetic pole, and the *Belgica* nearly 2,300 miles from the south magnetic pole. Toronto is 600 miles east of the agonic line, the *Belgica* 1,000 miles west of it.

If, then, anything is to be gained by comparing auroræ in homologous positions (which is very doubtful, as the condition of the air as to moisture, and electrical conductivity at various heights is changeable and seems to govern the brilliancy and colouring and even the character of the movements of auroral displays), better points must be chosen than the *Belgica*'s winter station and Toronto City.

Beautiful auroral displays here are, however, things of the past, owing to the electric lighting which now dims their brilliancy and dulls their colours. One must get beyond the range of arc and even incandescent lights to see the grandeur of the mighty illuminations which formerly often seemed to rival, if not to transcend, the glories of the dawn of day, whose name was for the time usurped. The opaline clouds, delicately tinged with exquisite elusive tints of ethereal amber, verging on chrome yellow, Niagara green, rose pink or spring lilac—sometimes

almost stationary and again waving, tripping, dancing, leaping in rapid measures—the embroidered curtains moved by celestial airs in delicate folds of entrancing grace, shedding or dropping a rain of heavenly light so beautiful that one could but gaze in silence and wonder and admire the great bows which spanned the heavens, having one end, it was felt, on the western mountains, and the other on the Atlantic Ocean—these are for the denizens of a large city, like the dreams of youth to the mature man, fond memories of vanished rapture.

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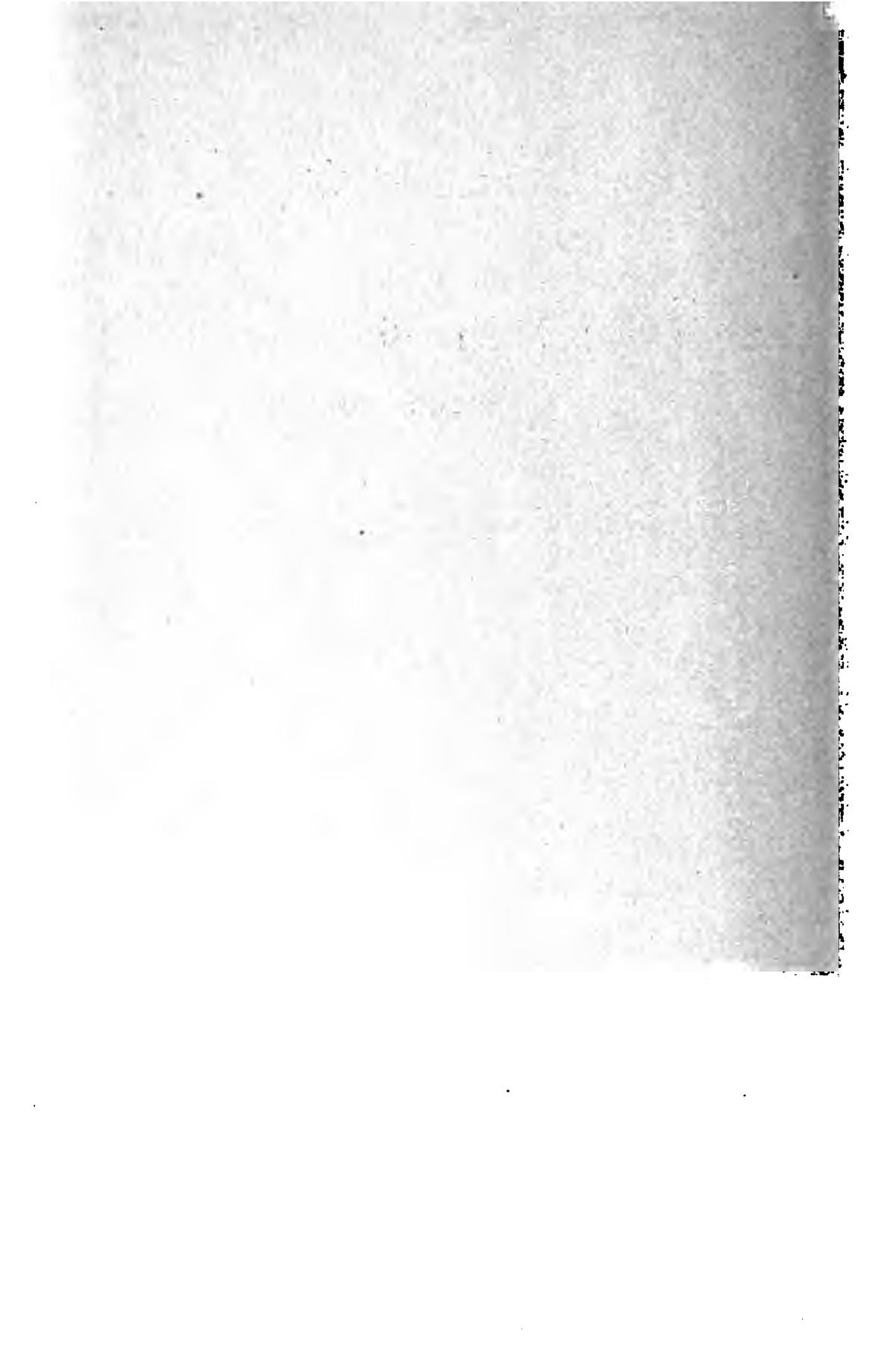
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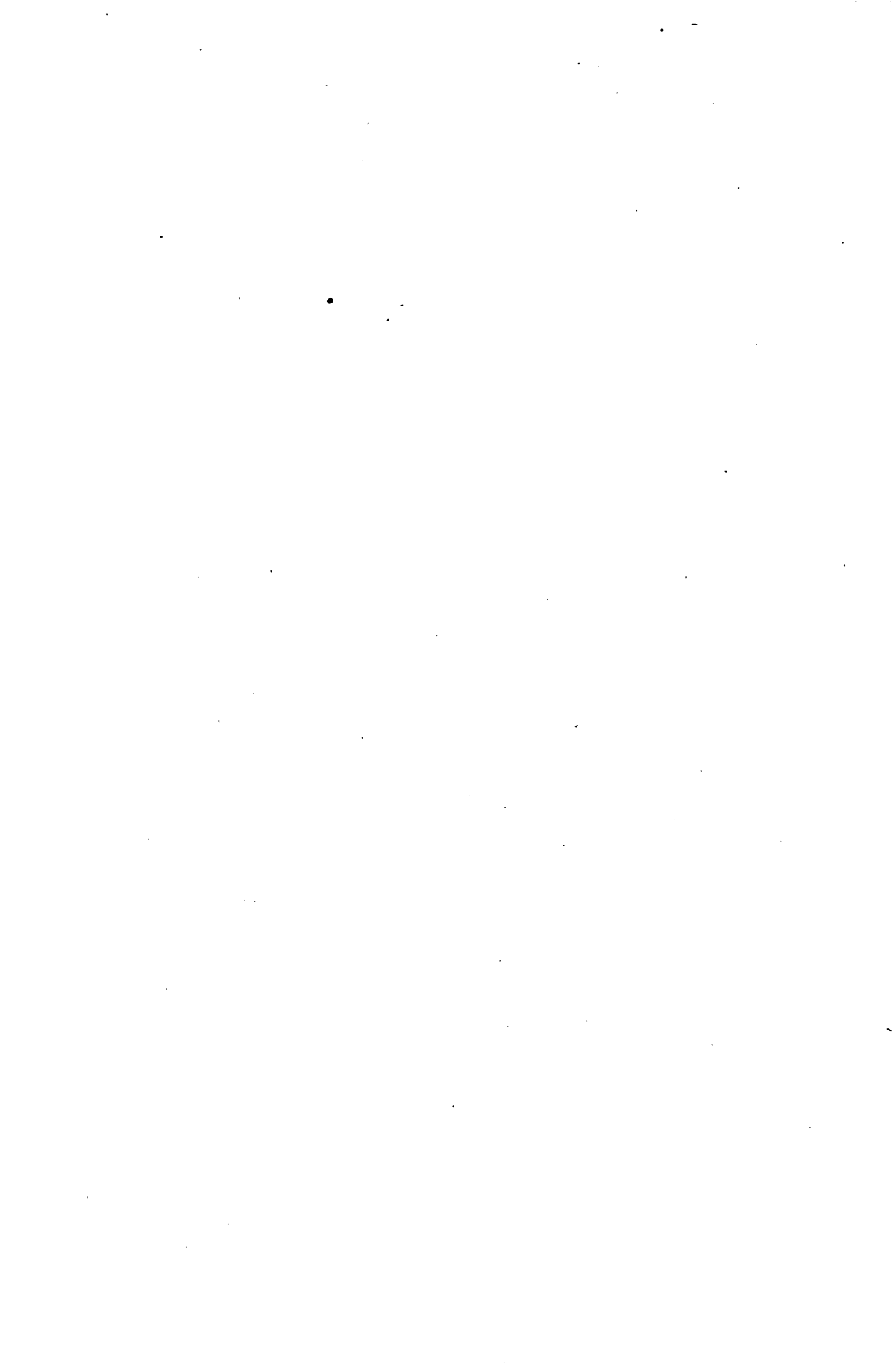
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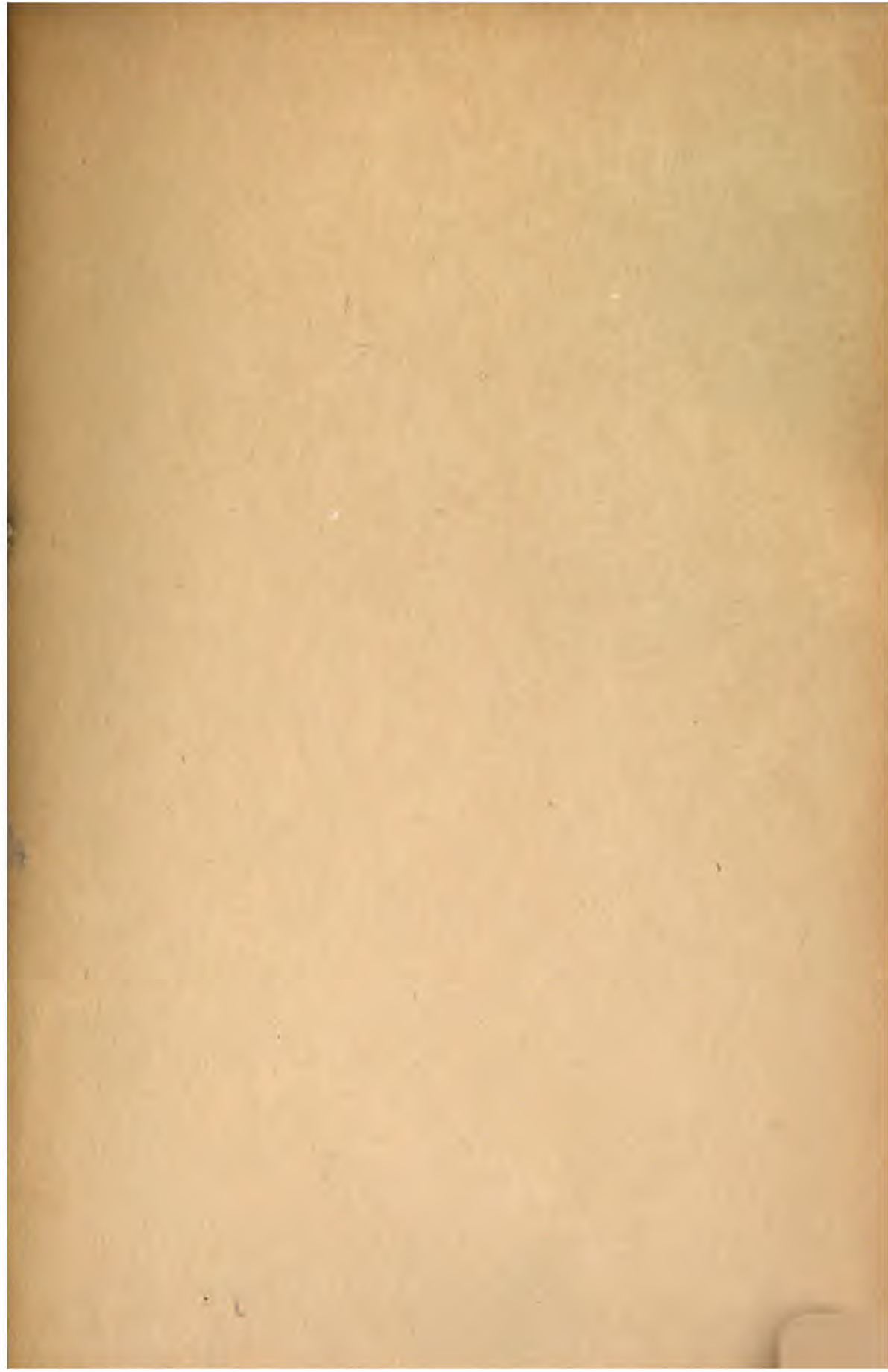
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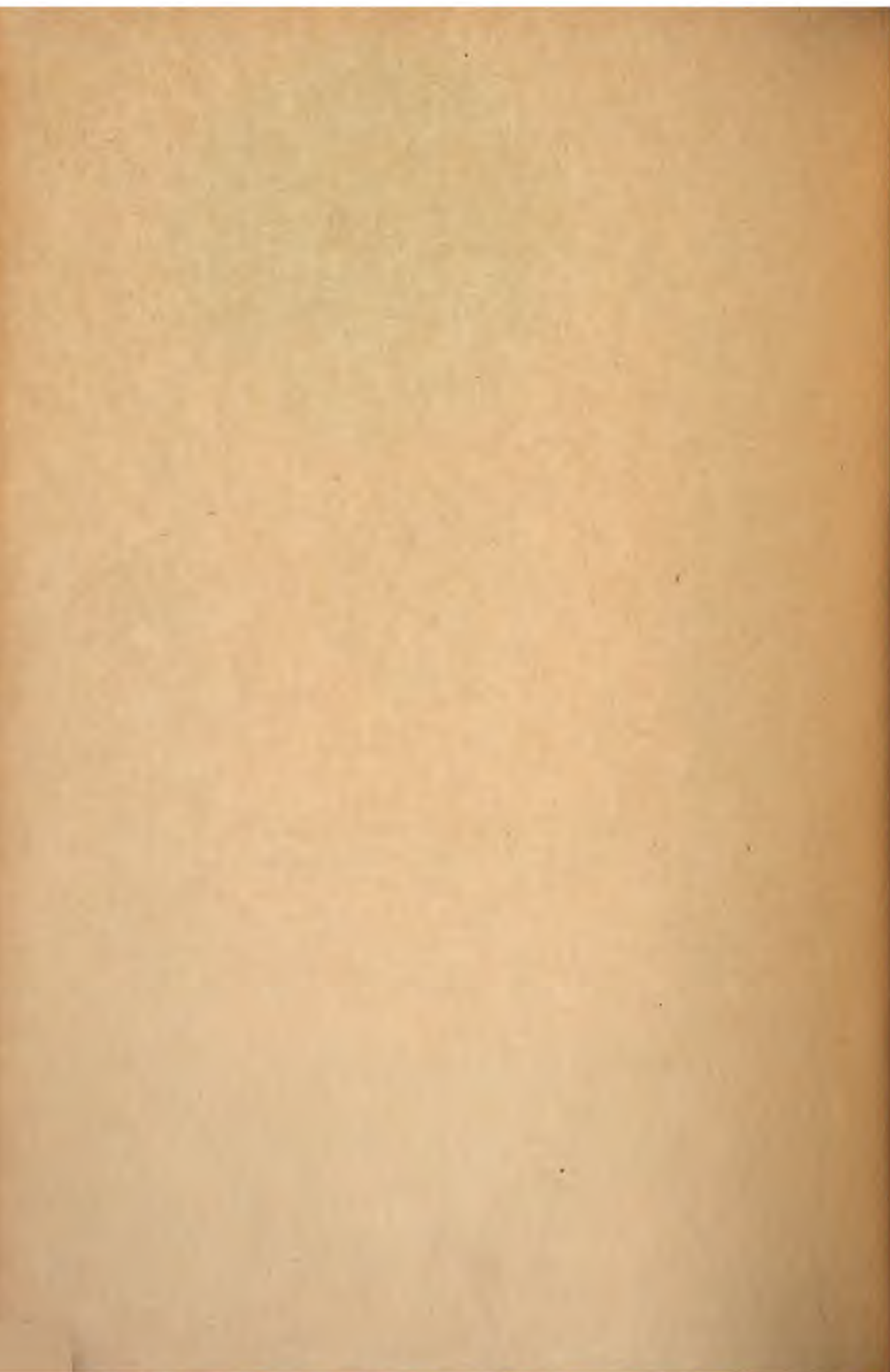
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